WL-TR-96-2013

ADVANCED TURBINE AEROTHERMAL RESEARCH RIG (ATARR) MONITOR AND CONTROL SYSTEM (MCS) HARDWARE REFERENCE MANUAL--VERSION 2

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MAY 1993

FINAL

AERO PROPULSION & POWER DIRECTORATE
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13. ABSTRACT *(Maximum 200 words)*
This manual is presented to WPAFB as an aid in sorting out the Monitor and Control System (MCS) hardware that was implemented by Belcan Corporation. Several revisions of the actual hardware have occurred, but until now, the documentation was scattered and not completely up-to-date. The main goals of this manual are to:

1. Consolidate the various hardware reference manuals and coordinate the manual with the existing wiring.
2. Outline the changes made by Calspan with regards to the main valve activation system and the isolation valve.
3. Provide a formal list of Calspan recommendations for the MCS system for future efforts.

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Table of Contents

Introduction:

This manual is presented to WPAFB as an aide in sorting out the Monitor and Control System (MCS) hardware that was implemented by Belcan Corporation. Several revisions of the actual hardware have occurred, but until now, the documentation was scattered and not completely up-to-date. The main goals of this manual are to:

1) Consolidate the various hardware reference manuals and coordinate the manual with the existing wiring.

2) Outline the changes made by Calspan with regards to the main valve activation system and the isolation valve

3) Provide a formal list of Calspan recommendations for the MCS system for future efforts.

The report is organized into two main sections. The first section is a discussion of the three items listed above. The second section contains the wiring diagrams and the reference material for the parts installed by Calspan. The wiring diagrams are organized a little differently from the original MCS hardware reference manual. In this section, all of the wiring diagrams generated by Paul Fuller are in Tab A. Tab B contains the general diagrams which show the power connections, placement of instruments, etc. (pages 3-7,11-12, and 17-19 of the original manual). These pages have not been checked by Calspan and are most probably incorrect, since many of the instruments, and the power supply for them have changed. Tab C contains the wiring diagrams for each Genius I/O block, grouped according to block number. To our knowledge these are presently correct. Tab D contains the wiring diagrams generated by Calspan for the main valve activation system. Finally, Tab E contains some reference information about the power supply, relays, and LEDs used in the main valve activation system.

All of the wiring diagrams were printed using MacDraft (Macintosh based software) and this document is generated using Microsoft Word. Computer disks are provided at the back of this report as well as a directory listing. Just about any computer drawing program and word processing program should be capable of accessing these files.

Section I: General MCS Discussion

I.1 Consolidation of Different Manuals

The wiring diagrams come from the original MCS hardware reference manual, Paul Fuller's working notebook, and Calspan wiring diagrams for the main valve system. In general, most of the wiring diagrams were generated before the entire system was installed. There were several items called out in the original plans for both the hardware and the software which were not fully implemented. The most notable example is the limit switches on many of the valves. While these valves were wired with limit switches, and the wires connected to the Genius I/O stations, they were either not connected to the Genius I/O blocks or the software was not implemented to use the limit switches. Since the Genius I/O blocks can be changed from input to output, several of these limit switches have been removed from the wiring diagrams, freeing up space to do other valve manipulations. These limit switches can be easily connected by finding (at the Genius I/O box) the appropriate wires (since the wires are already run to the limit switches). However, one may need to change the software to incorporate those changes.

Paul Fuller reworked most of the main circuitry for controlling the speed of the turbine. These changes are reflected in his drawings (contained in Tab A). However, his power connections are almost certainly different from the drawings noted in the introduction. Calspan has not been in a position to check these drawings for accuracy. This is a book keeping task that the Air force will have to assume.

At this point, we believe that these drawings represent the most up-to date version of the MCS. However, as parts are added (such as a cooling system or an enunciator panel) these connections will probably change. We encourage the Air force to keep this manual up-to-date, and remove non-functioning or outdated equipment quickly.

I.2 Calspan's Main Valve Activation System

Calspan assumed responsibility for developing the main valve activation system when it became clear that Belcan could not develop either the fast-acting valves or the fail-safe piping arrangement. The majority of this system is described in more detail in the "Main Valve Report"; here, only the electrical components are described.

The valves chosen to control the main valve activation system are Whitey 45 series valves with 120 VAC electric actuators. These actuators differ from the ones chosen by Belcan for many of their applications. These valves, when a set of leads are activated, move to a preset position and then shut the power off. Re-energizing the same leads will not make the valve move. This is extremely useful because power is only flowing when the valve is changing position. This makes for a much quieter (electrical) system. The downfall of this system is that the Genius I/O blocks are not isolated. Even when the power is off, high voltage potentials can exist between the two terminals (when power is off, the Genius manufactures mean that a very low current will flow). These voltage potentials were enough to cause some valves to actuate when they were not supposed to (an intermittent problem). This situation is solved by using a set of isolating relays. In fact GE manufactures relay blocks for the Genius I/O but they were not ordered because Belcan was using a system which had power on the entire time for all of their actuated valves (this approach results in the generation of lots of electrical noise).

Calspan built a set of relays to run the main valve activation system. There is nothing exceeding complex about the system. In fact many of the relays came from Radio Shack. These relays, as well as the power supply for the Marrotta valves, are enclosed in a box which has been attached to the Genius I/O box mounted near the supply tank. The wiring diagrams for the main valve are shown in Tab D. The first page shows the wiring diagram for the three Marrotta valves. One can see that the power for valve EV602 can only be obtained if EV603 and EV603' are activated.

Originally there were only two Marrotta valves (EV602 and EV603'). However, we ran into a problem with the system not maintaining pressure during one step of the activation process. This was because the limiting choke in the activation system is the Marrotta valves which required us to add one more valve (EV603'). This valve is activated exactly the same time as EV603 and is thus virtually indistinguishable from valve EV603. One will also note on this page the presence of the LM7812 chip. This was used to convert the power from the Power One #F28-12-A power supply into 12 VDC. This power was originally used to run the positioning LED's (on the Calspan actuators), and latter to power the positioning LED's on the main valve. The present system exists so that one could place two LED's on each of the Calspan actuators and channel that information to the MCS (in order to provide a reading of the position of the Calspan actuators). This diagram is shown on page two. Note that information about the Power One, LED's and Relays are contained in Tab E.

Page two shows the relays that have been installed to take the 12 VDC signal which is generated by the LEDs and use it as a control to the MCS. Presently the relays exist as does a power source for the LEDs, but the software is not written to interrogate these Genius I/O blocks, nor are there enough LEDs. Even if one did not wish to pursue this exact instrumentation, those relays could be used in other 12 VDC signal cases.

The third page shows the four relays used with the Whitey valves and actuators. Note that the Whitey actuators have built in limit switches of which only the main ones are wired. There are other switches which are available (such as an off position for three-way valves, and a motor running switch) which could easily be connected if desired.

One important point is that limit switches on the valves are used (for the Whitey valves), and the power is taken from the relay for the Marrotta valves. There is no implicit assumption made in the MCS that because you told the valve to move to a position that it is in that position. This is really a hardware closure versus a software closure. Originally the MCS software often assumed because the computer told a valve to change positions that it had done so. We have gone through the system and tried to remove those type of implicit assumptions when possible.

I.3 Isolation Valve Wiring

I.4 Calspan's Formal Recommendations Regarding the Future of the MCS

The MCS system is really a combination of three different sub-systems. First there is the MCS software and its operating environment. Secondly, there is the Genius I/O. Finally there is the instrumentation and valves. Calspan is uneasy about the existing MCS system. Presently it performs its functions, although we have concerns about its future. It is limited in what it can do, it cost to much to change and update, and it uses old technology. Be that as it may, we are compelled to use the system as it exists for now. However, we feel there are several cost effective ways of using the existing system while achieving better overall performance. In addition we feel that everyone involved must understand the limitations of the existing system. We feel that there will come a time in the not too distant future when the decision will need to be made to update the existing system at a substantial cost, or replace it. This sub-section intends to focus on some of the MCS limitations and make some suggestions for improving its overall operation.

I.4.1 MCS Limitations

As a forward, the overall MCS system is not limited by any one component in general, but rather it suffers from a cumulative effect of inadequacies in all three groups listed above. The software is extremely limiting. When Calspan first arrived, we created a new menu to control four valves on the main valve activation system. That additional space made the software uncompilable. After consultation with Belcan who indicated that they had a great deal of trouble compiling the code, an effort was undertaken to eliminate and streamline the code. At this point the software is approximately 2/3 of the original size. The unfortunate part is that the actual logic contained in the code (i.e. if this valve is open check this and that) can be written in about 10 pages (out of over 100). Most of the written code is used to run the windows format. Clearly as the facility expands to include a cooling system, temperature generator, etc., the main control software could easily reach its limits. It seems rather arcane to spend so much software overhead trying to generate a windows atmosphere (which can not run separate windows), while there are operating systems that already do that (UNIX).

In terms of the hardware, the Genius I/Os are limited to a finite number of blocks (30) per controller. While there is still some expansion room, clearly the software may limit one to an effective number which is probably smaller than the maximum hardware limit. More importantly, as the number of blocks grow, the communication time delay increases. Already at this point, the MCS cannot be used to do highly accurate timing, which will be a problem when systems such as the cooling system are brought on line. Buying some Genius relay blocks should alleviate the need to do extra relay wiring when using electrically actuated valves, which has been a limitation, to some degree.

Our biggest concern has always been with the MCS instrumentation, particularly the pressure transducers. While we are not happy that many of the valves are AC activated and remain as power drains during the entire time they are activated, this is not as large a problem as the pressure transducers.

Much of the cost of these transducers was spent on the communications components of the transducers. The actual transducers are not very accurate, plus one needs two of them for every tank which is both evacuated and pressurized. These transducers are expensive because there is an A/D chip inside every one. That is why one can scale the output at the transducer itself. This, when coupled with the A/D in the Genius I/O and the A/D inside the computer makes for a system with three potential places to do A/D work (or confuse the signal). The transducers are designed for systems which do not have computers to do the digitization (or for those systems which need a back-up independent of the main computer system), neither of which we need. In addition the frequency response is extremely low, making them almost completely worthless as diagnostic equipment. They cannot be moved easily, nor can they all be calibrated together. They must be calibrated separately, which could cause a bias error to develop in the system, limiting the overall relative accuracy that could be obtained. In addition, they were selected to have 4-20 ma current loops. This probably seemed advantageous to the designer because only two wires are needed for each instrument; however, it adds cost to the instrument and makes on-line diagnostics annoying (even if using the programmer) and impossible without the device.

Finally as a clear indication of the quality of the transducers themselves, the MCS software vents the tanks until the pressure transducers read atmospheric conditions. However, even after calibration, the difference between atmospheric pressure and the pressure transducer readings could be a few psi. This event has occurred on several occasions where we removed an access plate only to hear more air escaping. Since then, manual MCS vents (i.e. ones that stay open until someone closes them) have been installed in the software which allow the operator to override the pressure transducer signals and make sure the tanks are fully vented before starting to work on the system.

I.4.2 MCS Suggestions

Clearly we feel that the pressure transducers should be replaced as they begin to fail. These can be replaced much more inexpensively by using standard high voltage output transducers (such as from Omega). Most of these can be obtained in absolute format which will mean that only one transducer will need to be used for both vacuum and pressure readings. This would cut-down on the MCS software needed and the hardware slots. One would have to obtain a power supply, but that is relatively inexpensive and could be used to power all the transducers. The MCS could then be reconfigured to use a voltage input rather than a 4-20 ma current loop. This will make diagnostic work much easier since it can all be done at the Genius I/O blocks. In addition, if the pressure transducers were all standardized to 1/2" swagelock caps, they could be removed and calibrated together and with the test rig instrumentation. This would help reduce the overall relative error in the system. Plus, these types of pressure transducers generally have much higher frequency response.

Another suggestion is to actively limit what the MCS software needs to do. One example is that the traversing rings will be run from the Sun computer. Another example is to make a separate hardware timed trigger system, which controls the timing of the main valve, isolation valve, eddy, brake, etc. Thus all the MCS software has to do is send one initial trigger signal. Finally, if there are going to be large subsystems (such as cooling), think about adding a different PC controlled system with a different operating system. This provides both experience with other systems, and reduces the overall burden on the MCS.

Appendix: Computer Disks and Listings

Name	Size	Kind	Label	Last Modified
M.V. Box pg 1 of 3	22K	MacDraft document	—	Thu, Apr 29, 1993, 5:25 PM
M.V. Box (page 3 of 3)	28K	MacDraft document	—	Fri, Apr 30, 1993, 10:45 AM
M.V. Box (pg 2 of 3)	19K	MacDraft document	—	Fri, Apr 30, 1993, 9:47 AM
MCS Hardware referenc...	19K	Microsoft Word do...	—	Fri, Apr 30, 1993, 2:03 PM
sheet 10 of 31	37K	MacDraft document	—	Wed, Apr 28, 1993, 1:30 PM
Sheet 13	37K	MacDraft document	—	Wed, Apr 28, 1993, 7:17 PM
Sheet 15 of 31	34K	MacDraft document	—	Wed, Aug 19, 1992, 8:55 PM
sheet 16 of 31	35K	MacDraft document	—	Wed, Aug 19, 1992, 9:18 PM
Sheet 17	27K	MacDraft document	—	Wed, Apr 28, 1993, 7:34 PM
Sheet 2 of 31	133K	MacDraft document	—	Wed, Apr 28, 1993, 1:17 PM
Sheet 20	39K	MacDraft document	—	Wed, Apr 28, 1993, 3:11 PM
Sheet 21 of 31	39K	MacDraft document	—	Wed, Aug 19, 1992, 9:33 PM
sheet 22 of 31	39K	MacDraft document	—	Wed, Apr 28, 1993, 7:28 PM
sheet 23 of 31	37K	MacDraft document	—	Wed, Apr 28, 1993, 6:39 PM
sheet 24 of 31	36K	MacDraft document	—	Wed, Apr 28, 1993, 1:51 PM
Sheet 25 of 31	37K	MacDraft document	—	Fri, Apr 30, 1993, 11:10 AM
Sheet 26	34K	MacDraft document	—	Fri, Apr 30, 1993, 11:37 AM
Sheet 27	33K	MacDraft document	—	Wed, Apr 28, 1993, 5:45 PM
Sheet 28	32K	MacDraft document	—	Wed, Apr 28, 1993, 3:06 PM
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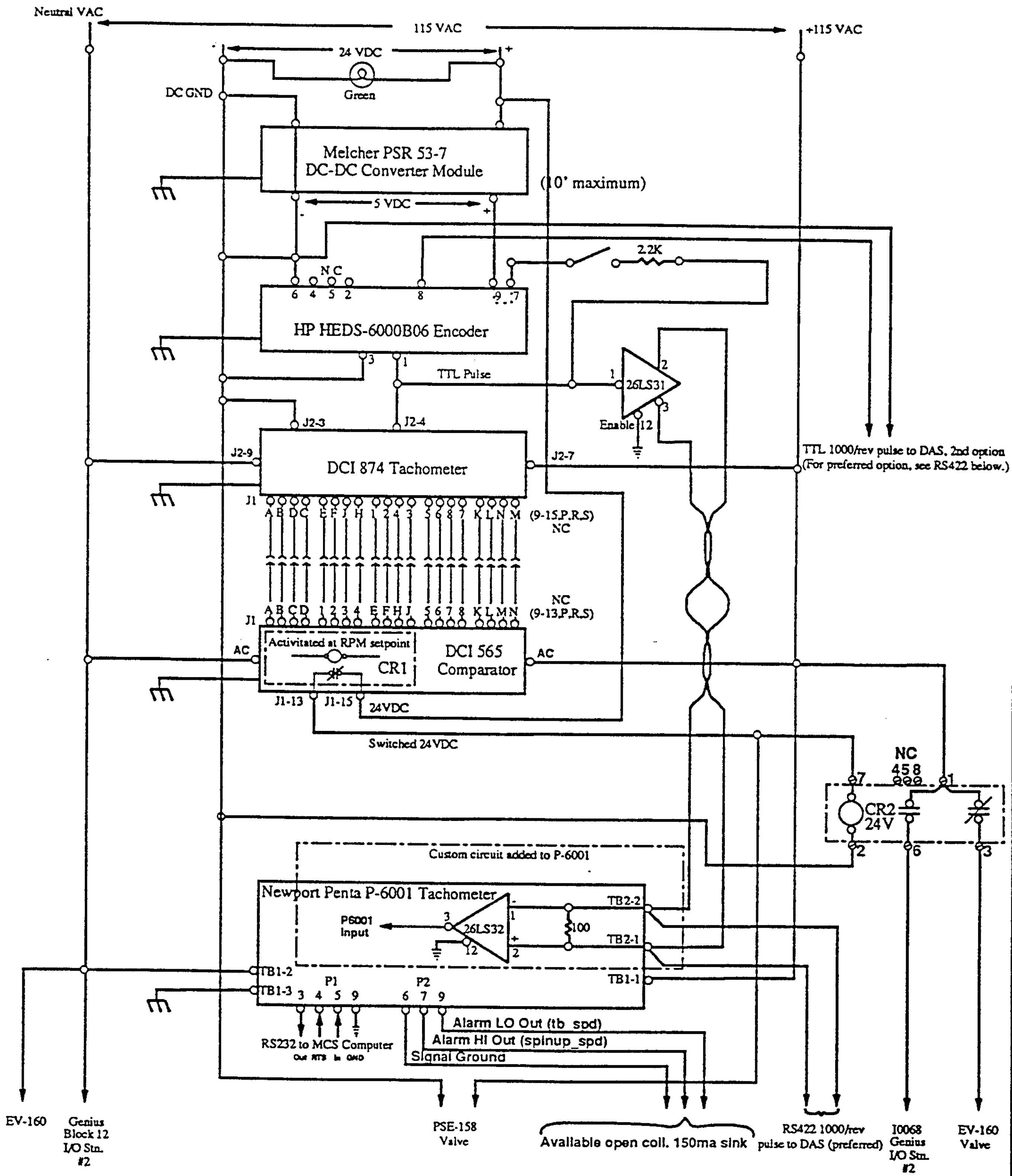
sheet 8 of 31	36K	MacDraft document	—	Wed, Apr 28, 1993, 1:46 PM
sheet 9 of 31	38K	MacDraft document	—	Fri, Apr 30, 1993, 11:37 AM

Section II: Wiring Diagrams



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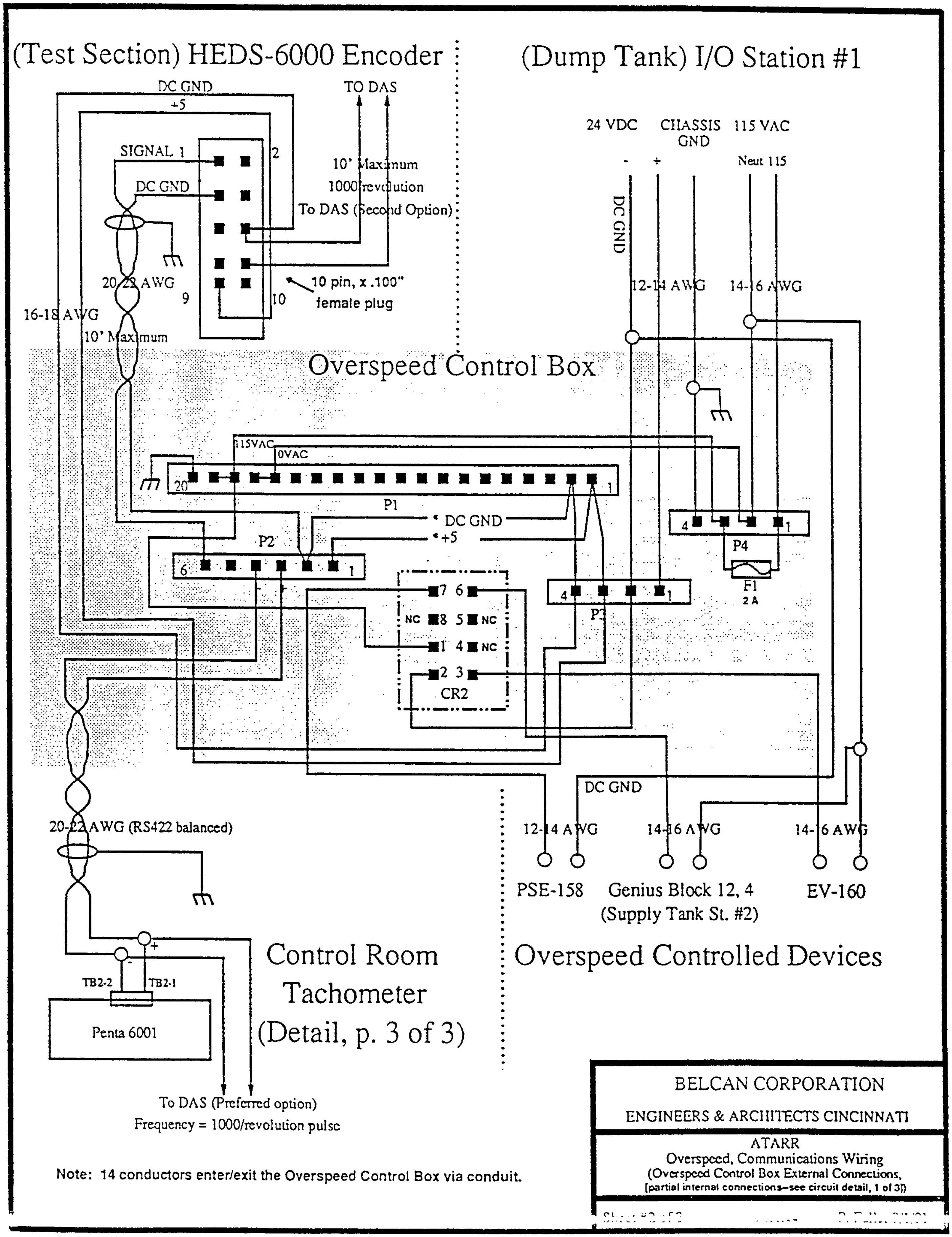
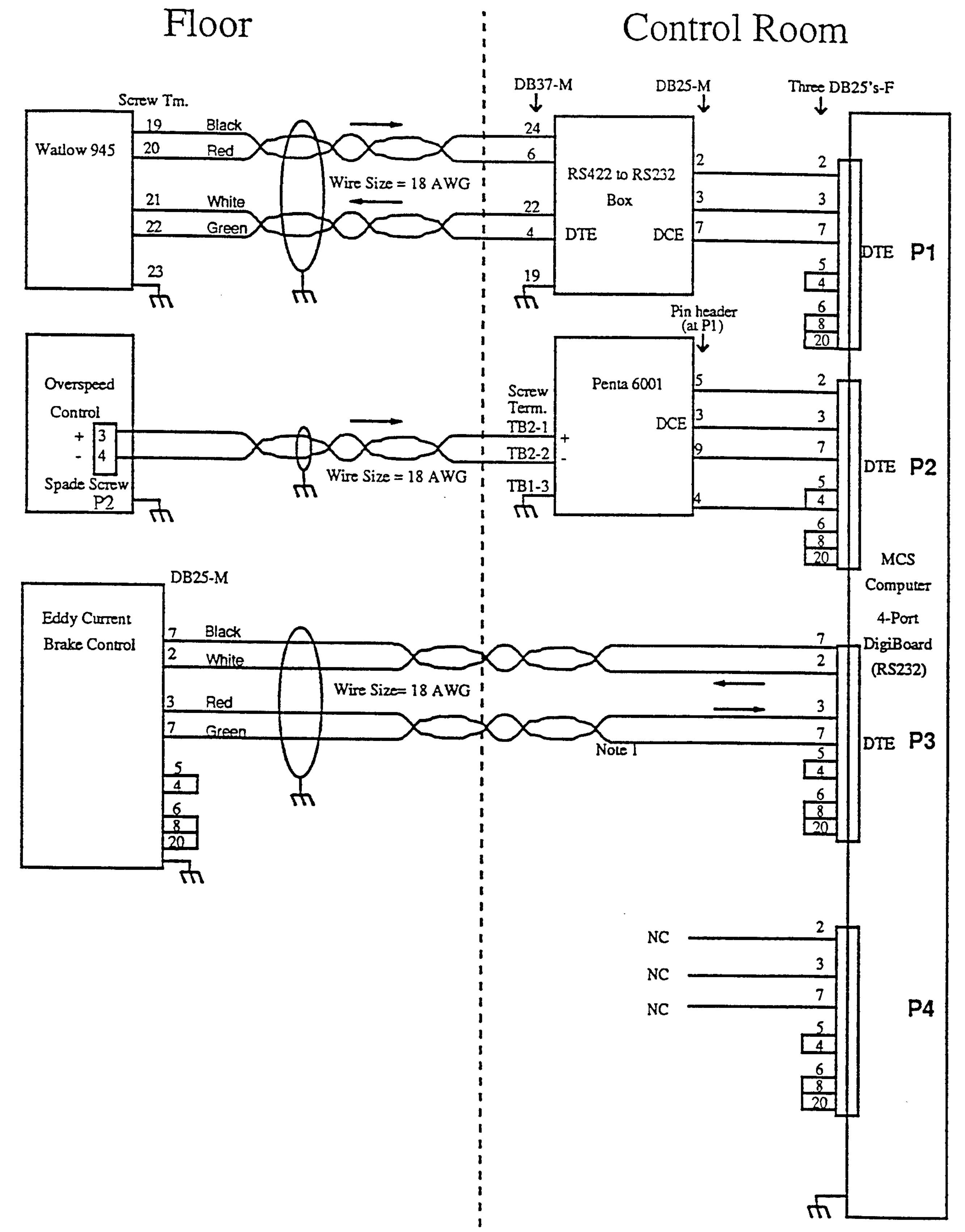
ATARR
Overspeed, Communications Wiring
(Overspeed Control Circuit)


(Test Section) HEDS-6000 Encoder
(Dump Tank) I/O Station #1
DC GND
+5
TO DAS
SIGNAL 1
DC GND
2
10' Maximum
1000/revolution
To DAS (Second Option)
20-22 AWG
9
10
10 pin, x .100"
female plug
16-18 AWG
10' Maximum
24 VDC
CHASSIS GND
115 VAC
- +
Neut 115
DC GND
12-14 AWG
14-16 AWG
Overspeed Control Box
115VAC
0VAC
20
1
P1
DC GND
+5
P2
6
1
P4
F1
2 A
P3
4
1
7 6
NC 8 5 NC
1 4 NC
2 3
CR2
DC GND
12-14 AWG
14-16 AWG
14-16 AWG
PSE-158
Genius Block 12, 4
(Supply Tank St. #2)
EV-160
20-22 AWG (RS422 balanced)
TB2-2
TB2-1
Penta 6001
Control Room
Tachometer
(Detail, p. 3 of 3)
Overspeed Controlled Devices
To DAS (Preferred option)
Frequency = 1000/revolution pulse
Note: 14 conductors enter/exit the Overspeed Control Box via conduit.
BELCAN CORPORATION
ENGINEERS & ARCHITECTS CINCINNATI
ATARR
Overspeed, Communications Wiring
(Overspeed Control Box External Connections,
[partial internal connections--see circuit detail, 1 of 3])



Note 1. Dual STP used for possible conversion to balanced transmission if environment requires.

Note 2. 18 AWG Shielded wire on all illus. floor-to-control-room circuits.

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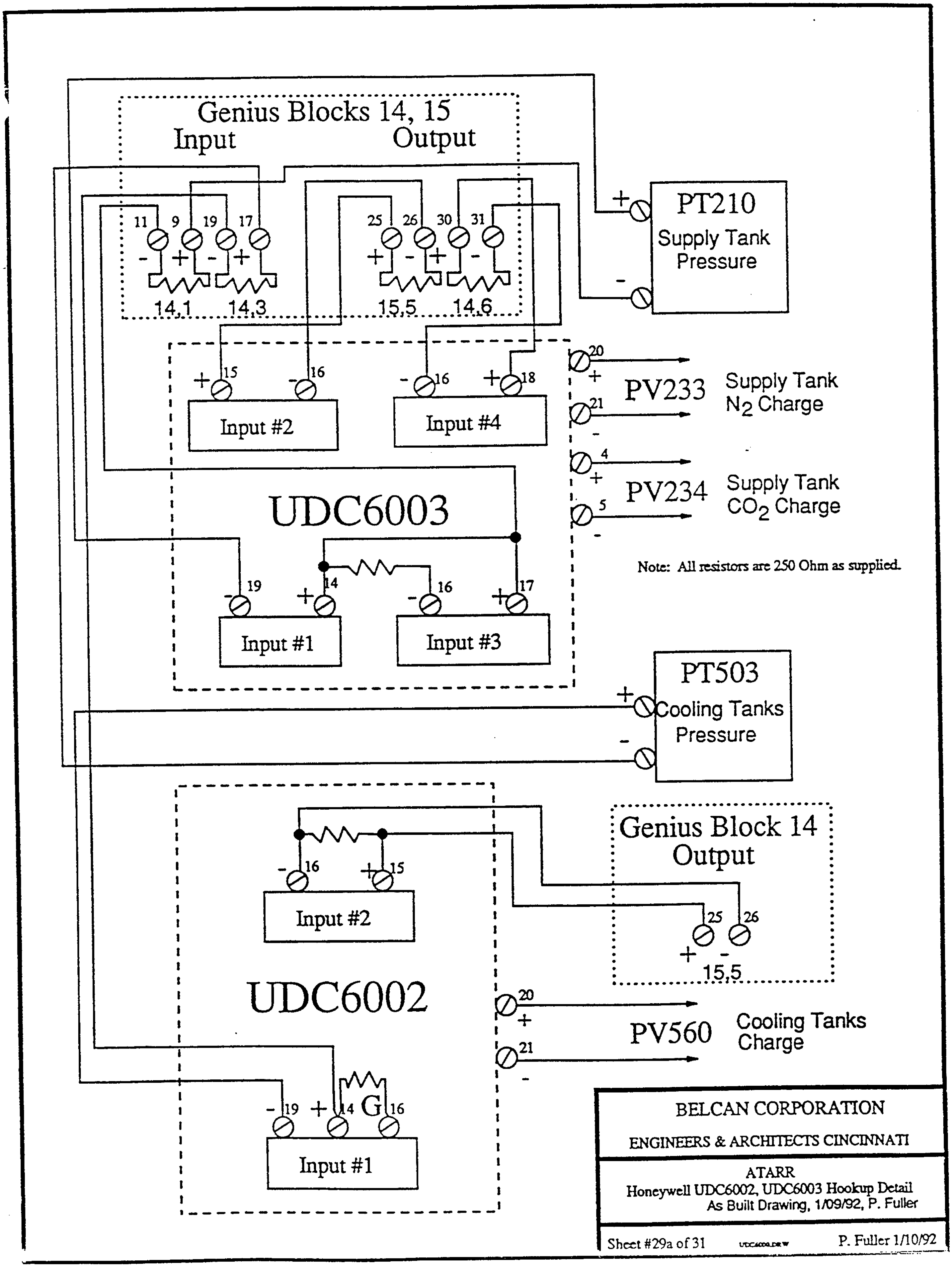
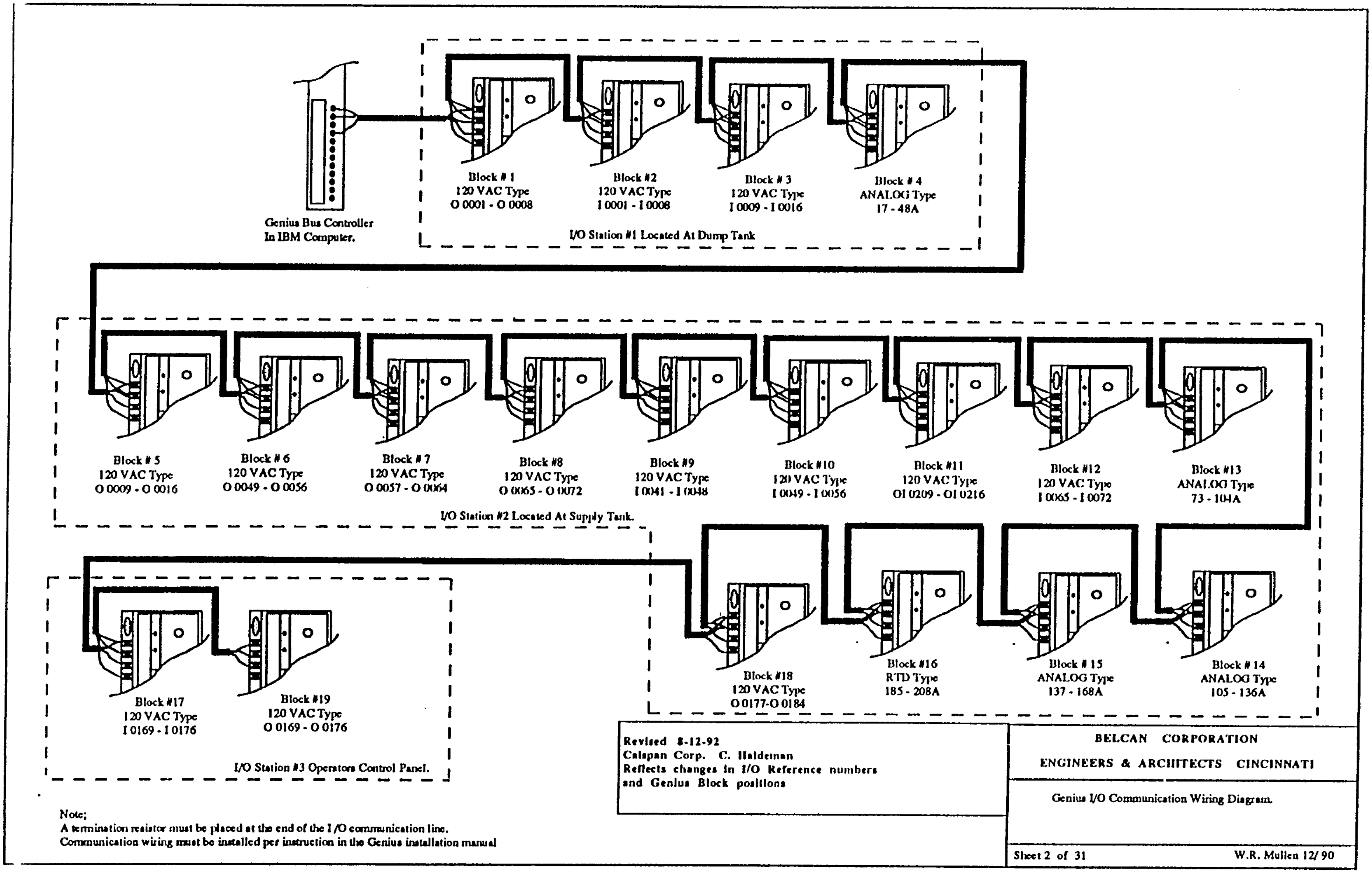
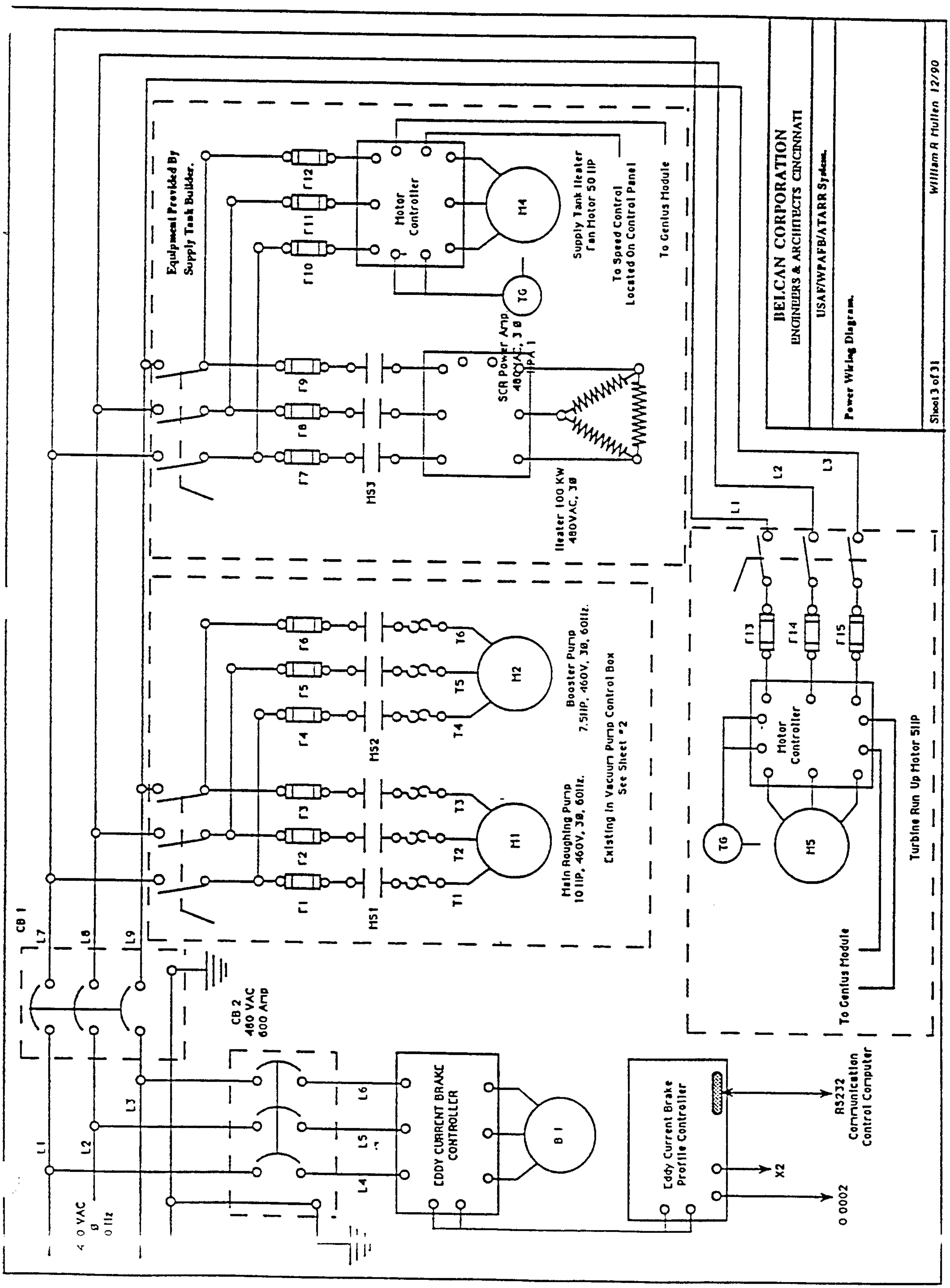
ATARR

Overspeed, Communications Wiring

Sheet #3 of 3 P. Fuller 1/10/92


Genius Blocks 14, 15
Input
Output
11 9 19 17
25 26 30 31
14,1 14,3 15,5 14,6
PT210
Supply Tank Pressure
Input #2
Input #4
15 16 16 18
PV233
Supply Tank N2 Charge
PV234
Supply Tank CO2 Charge
UDC6003
Note: All resistors are 250 Ohm as supplied.
19 14 16 17
Input #1
Input #3
PT503
Cooling Tanks Pressure
Genius Block 14
Output
25 26
15,5
16 15
Input #2
UDC6002
PV560
Cooling Tanks Charge
19 14 G 16
Input #1
BELCAN CORPORATION
ENGINEERS & ARCHITECTS CINCINNATI
ATARR
Honeywell UDC6002, UDC6003 Hookup Detail
As Built Drawing, 1/09/92, P. Fuller
Sheet #29a of 31
P. Fuller 1/10/92


Genius Bus Controller
In IBM Computer.
Block # 1
120 VAC Type
O 0001 - O 0008
Block #2
120 VAC Type
I 0001 - I 0008
Block # 3
120 VAC Type
I 0009 - I 0016
Block # 4
ANALOG Type
17 - 48A
I/O Station #1 Located At Dump Tank
Block # 5
120 VAC Type
O 0009 - O 0016
Block # 6
120 VAC Type
O 0049 - O 0056
Block # 7
120 VAC Type
O 0057 - O 0064
Block #8
120 VAC Type
O 0065 - O 0072
Block #9
120 VAC Type
I 0041 - I 0048
Block #10
120 VAC Type
I 0049 - I 0056
Block #11
120 VAC Type
OI 0209 - OI 0216
Block #12
120 VAC Type
I 0065 - I 0072
Block #13
ANALOG Type
73 - 104A
I/O Station #2 Located At Supply Tank.
Block #18
120 VAC Type
O 0177-O 0184
Block #16
RTD Type
185 - 208A
Block # 15
ANALOG Type
137 - 168A
Block # 14
ANALOG Type
105 - 136A
Block #17
120 VAC Type
I 0169 - I 0176
Block #19
120 VAC Type
O 0169 - O 0176
I/O Station #3 Operators Control Panel.
Note;
A termination resistor must be placed at the end of the I/O communication line.
Communication wiring must be installed per instruction in the Genius installation manual
Revised 8-12-92
Calspan Corp. C. Haldeman
Reflects changes in I/O Reference numbers
and Genius Block positions
BELCAN CORPORATION
ENGINEERS & ARCHITECTS CINCINNATI
Genius I/O Communication Wiring Diagram.
Sheet 2 of 31
W.R. Mullen 12/90


BELCAN CORPORATION
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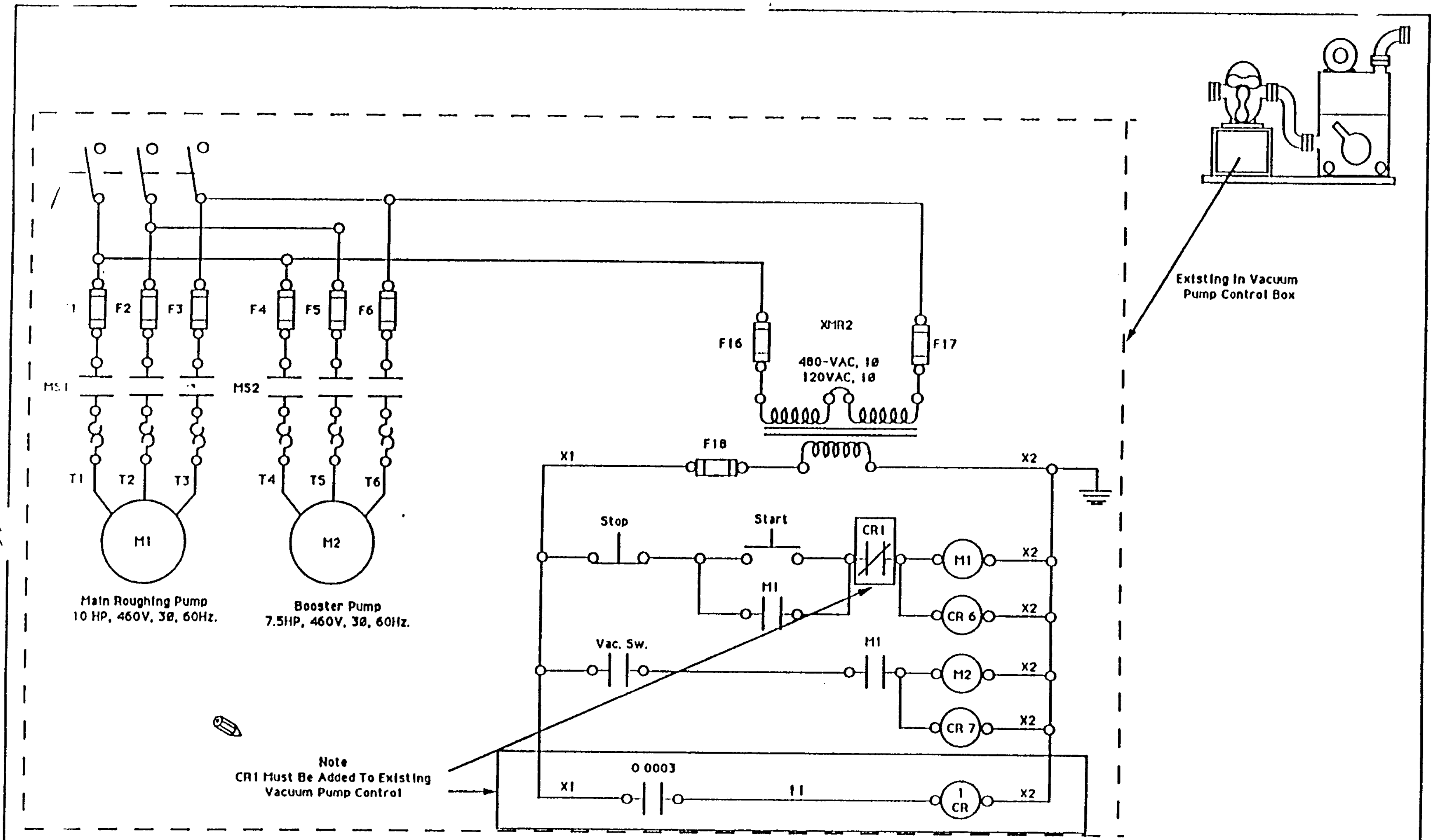
USAF/WPAFB/ATARR System
Power Wiring Diagram
William R Hullen 12/90
Sheet 3 of 31
Equipment Provided By Supply Tank Builder.
Motor Controller
M4
TG
Supply Tank Heater Fan Motor 50 HP
To Speed Control Located On Control Panel
To Genius Module
SCR Power Amp
Heater 100 KW 480VAC, 3Ø
MS3
MS2
MS1
M1
M2
Main Roughing Pump 10 HP, 460V, 3Ø, 60Hz.
Booster Pump 7.5HP, 460V, 3Ø, 60Hz.
Existing In Vacuum Pump Control Box See Sheet #2
M5
Turbine Run Up Motor 5HP
CB 1
CB 2 480 VAC 600 Amp
EDDY CURRENT BRAKE CONTROLLER
B 1
Eddy Current Brake Profile Controller
RS232 Communication Control Computer
X2
L1
L2
L3
L4
L5
L6
L7
L8
L9
T1
T2
T3
T4
T5
T6



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USAF/WPAFB/ATARR System.

Vacuum Pump Control (Typical See Stokes Wiring Diagram)

Sheet 4 of 31	*William R. Mullen 12/90*

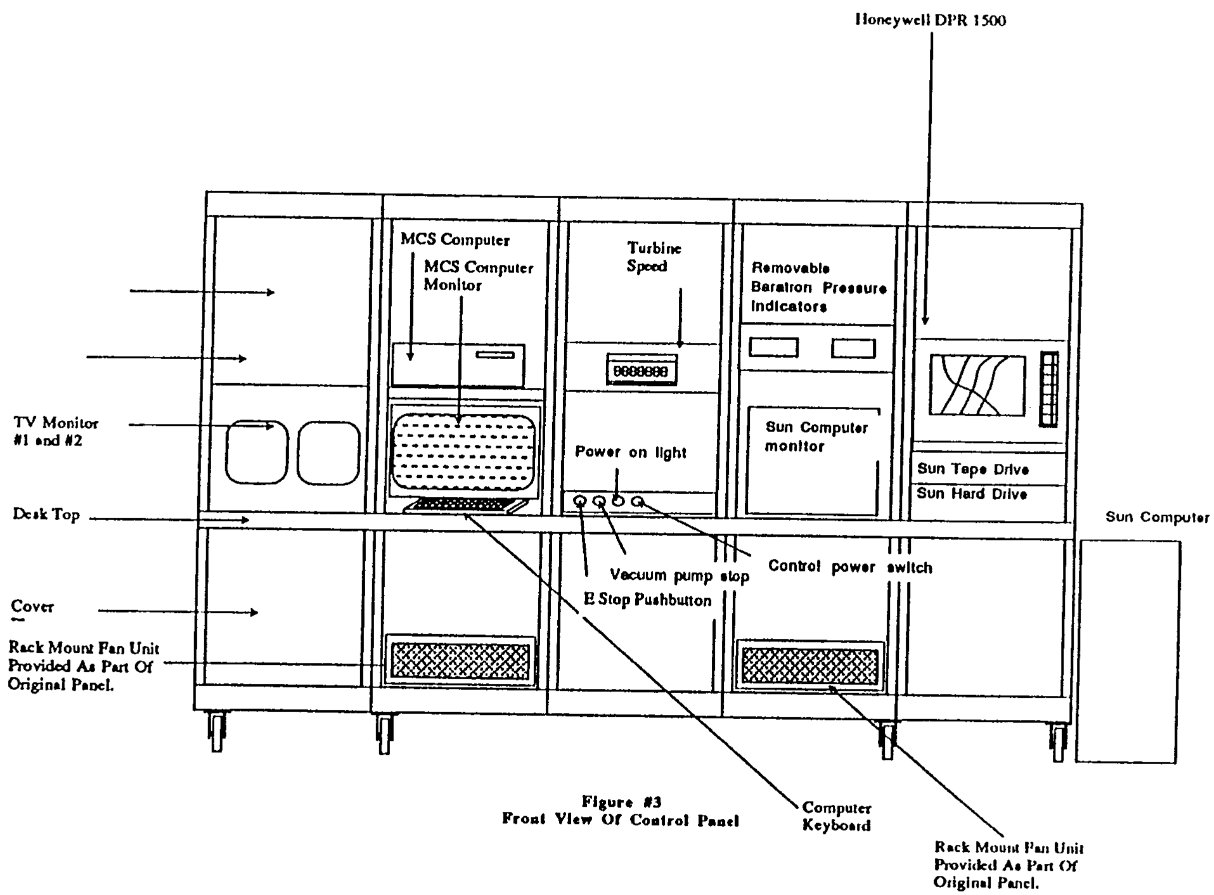


Figure #3
Front View Of Control Panel

Control Panel is made up of five standard 19" X 84" X 32" units.

These racks are complete and assembled with 6" wheels and the desk top mounted in the correct position.

Some 19" cover / mounting plates are presently in place. However, some have obsolete instrumentation mounted, this instrumentation along with the wiring must be removed for USAF storage. The Contractor shall provide the necessary new panel mounting / cover plates to complete the control panel .

All mounting / cover plates shall be the same color (Color selected by the end user of the equipment.).

Ventalation to meet the requirements of the Original Equipment Vendor must be provided by the Contractor. Two 19" rack mount fan units are provided as part of this existing unit and may be used for ventalation.

Revised 8-19-92
Calspan Corp.
C. Haldeman

Reflects changes made to control panel by Belcan and the addition of the Sun computer

BELCAN CORPORATION
ENGINEERS & ARCHITECTS CINCINNATI

USAF/WPAFB/ATARR System.

Control Pannel Layout
(See Sheet #4 For Details.

Sheet 5 of 31 — *William R. Mullen 12 /90*

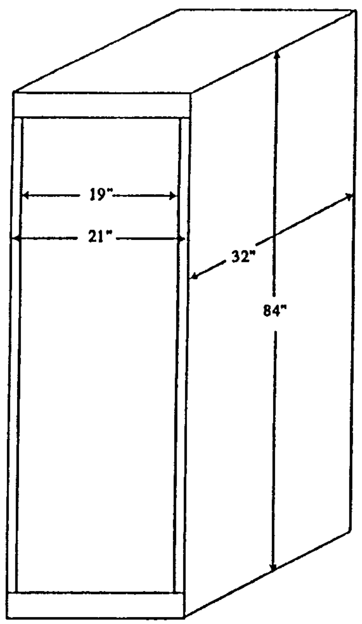


Figure #1
Control Panel Basic Unit

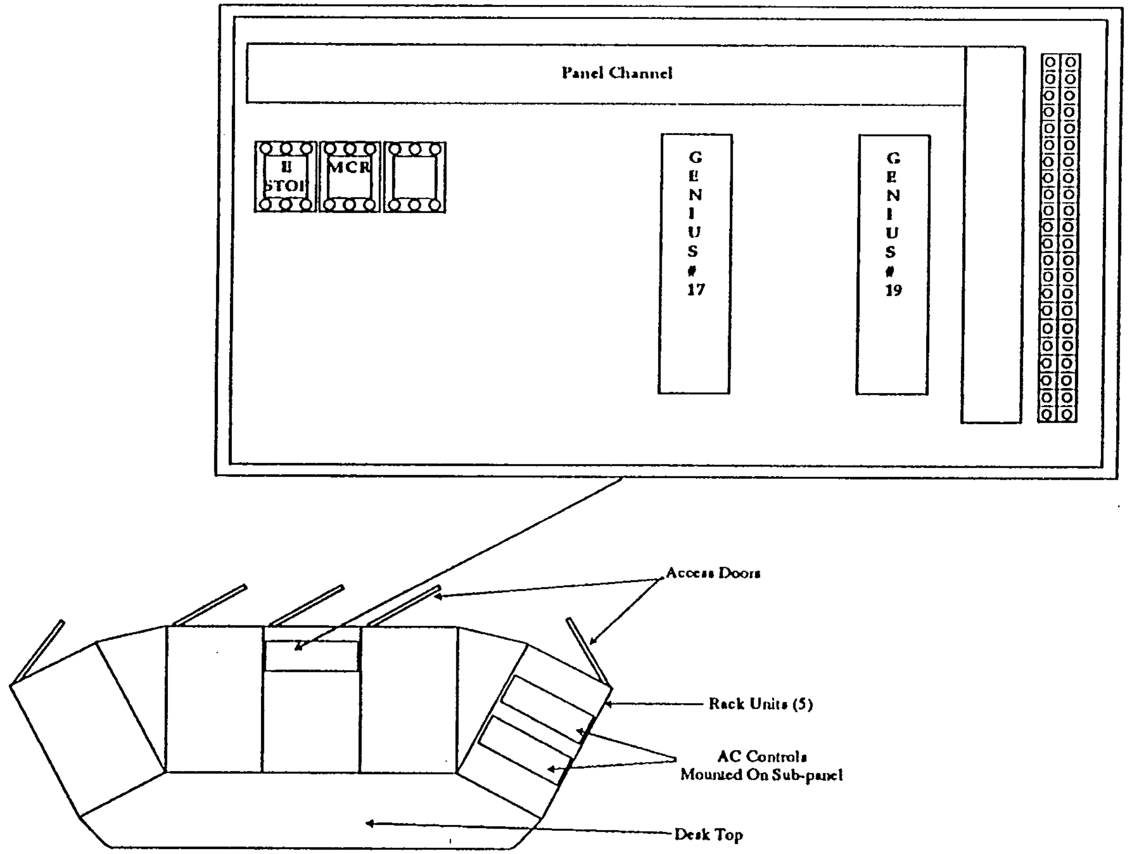
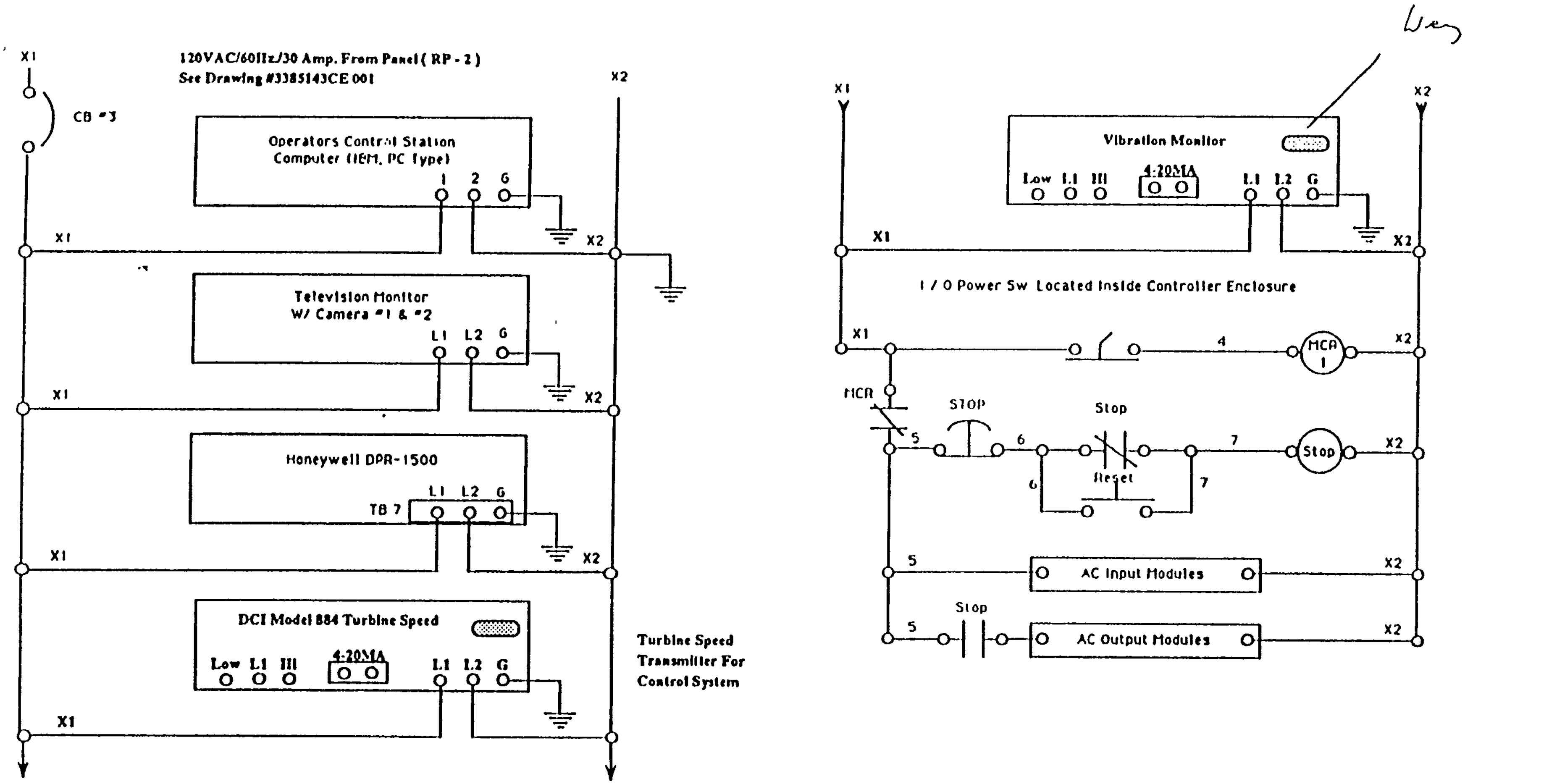


Figure #2
Top View Of Panel

The units are presently assembled in this configuration and will not require modification.

Calspan Corp.	BELCAN CORPORATION ENGINEERS & ARCHITECTS CINCINNATI
Reflects Change in module 18 location	USAF/WPAFB/ATARR System.
	Detail Of Control Panel Assembly
Revised 8-12-92 C. Haldeman	Sheet 6 of 31 William R. Mullen 12/90



BELCAN CORPORATION
ENGINEERS & ARCHITECTS CINCINNATI

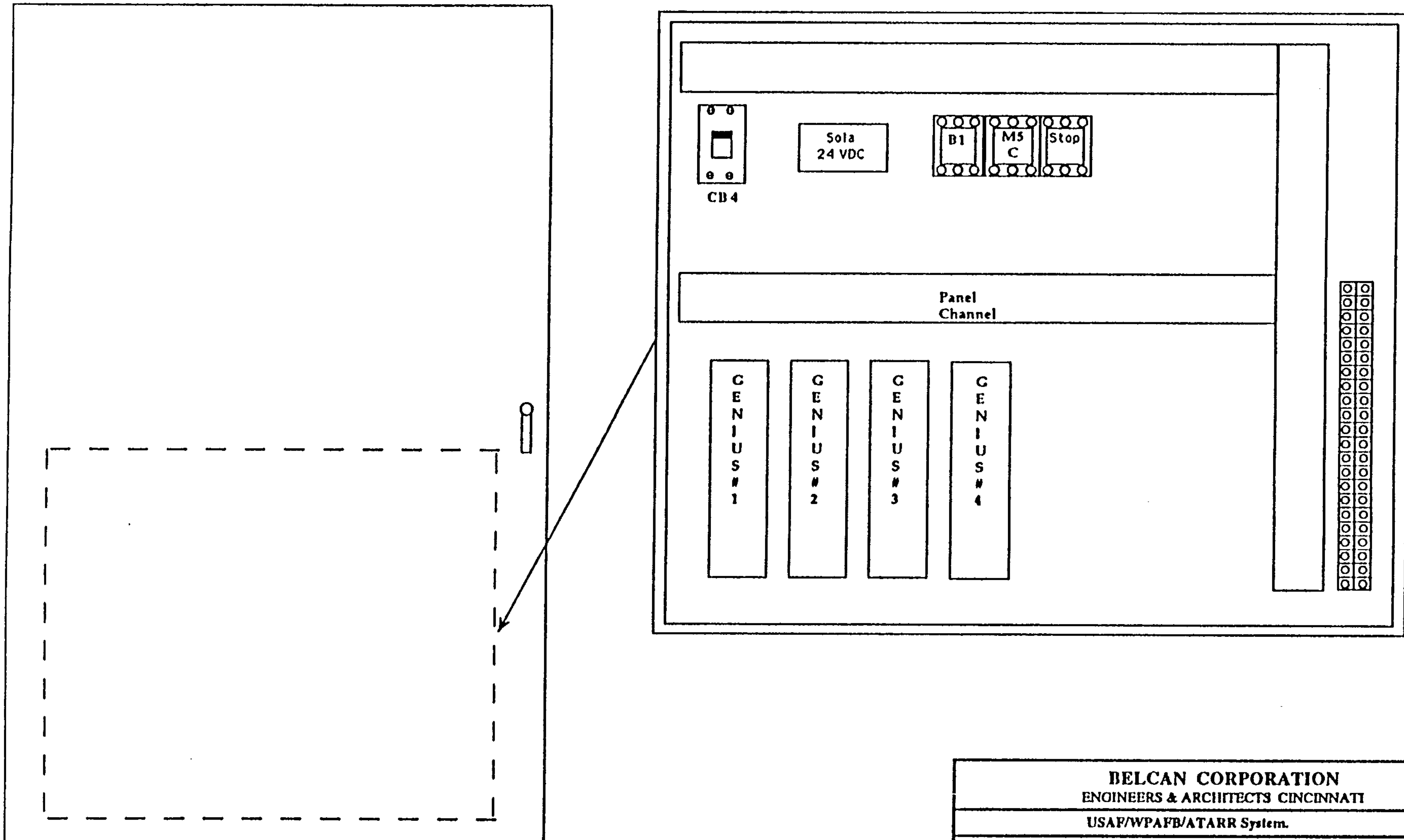
USAF/WPAFB/ATARR System.

Operator Control Panel Wiring.

Revised : 3-8-1991 By J.R.

Sheet 7 of 31 William R Mullen 12/90

Wrong



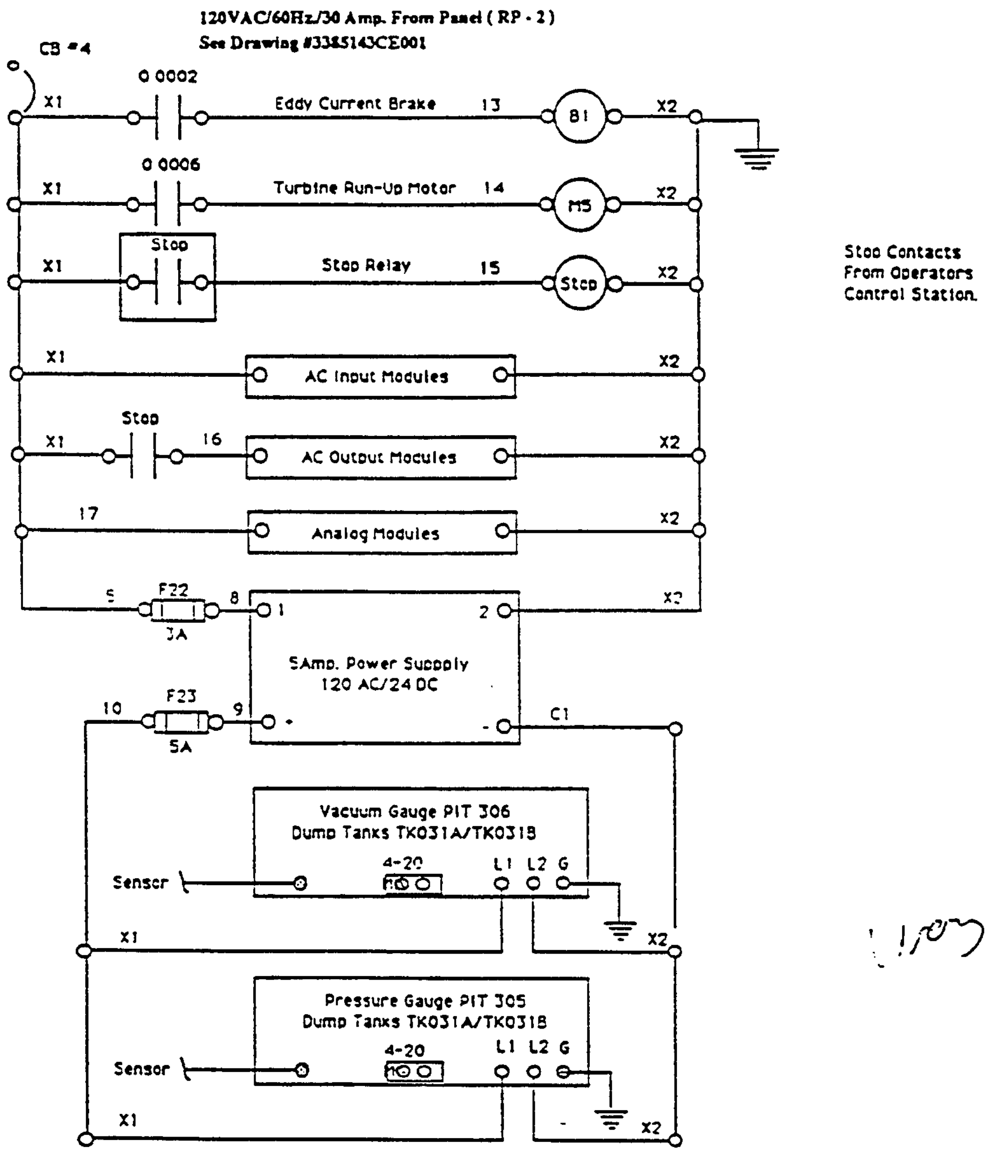
BELCAN CORPORATION
ENGINEERS & ARCHITECTS CINCINNATI

USAF/WPAFB/ATARR System.

Control Station #1, Panel Front & Sub-Panel.

Revised : 3-8-1991 By J.R.

Sheet 11 Of 31 *William R. Mullen 12/90*



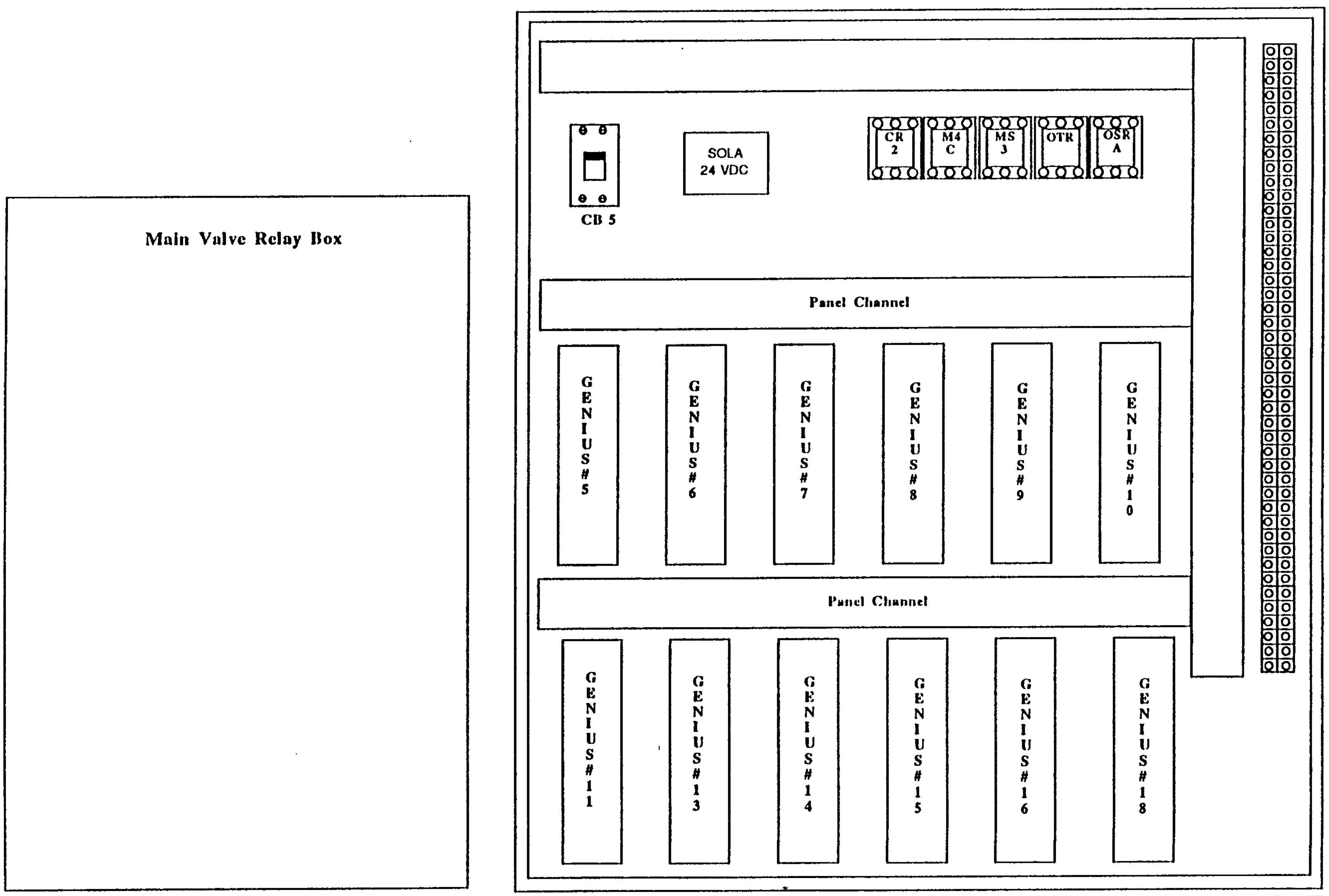
BELCAN CORPORATION
ENGINEERS & ARCHITECTS CINCINNATI

USAF/WPAFB/ATARR System.

I/O Station #1 Wiring Diagram.

Revised : 3-8-1991 By J.R.

William R. Mullen 12/90 Sheet 12 of 31



Calspan Corporatior

Revised to include Main Valve Relay Box
and to eliminate Pike Valve Controller

4-28-93
C. Haldeman

BELCAN CORPORATION
ENGINEERS & ARCHITECTS CINCINNATI

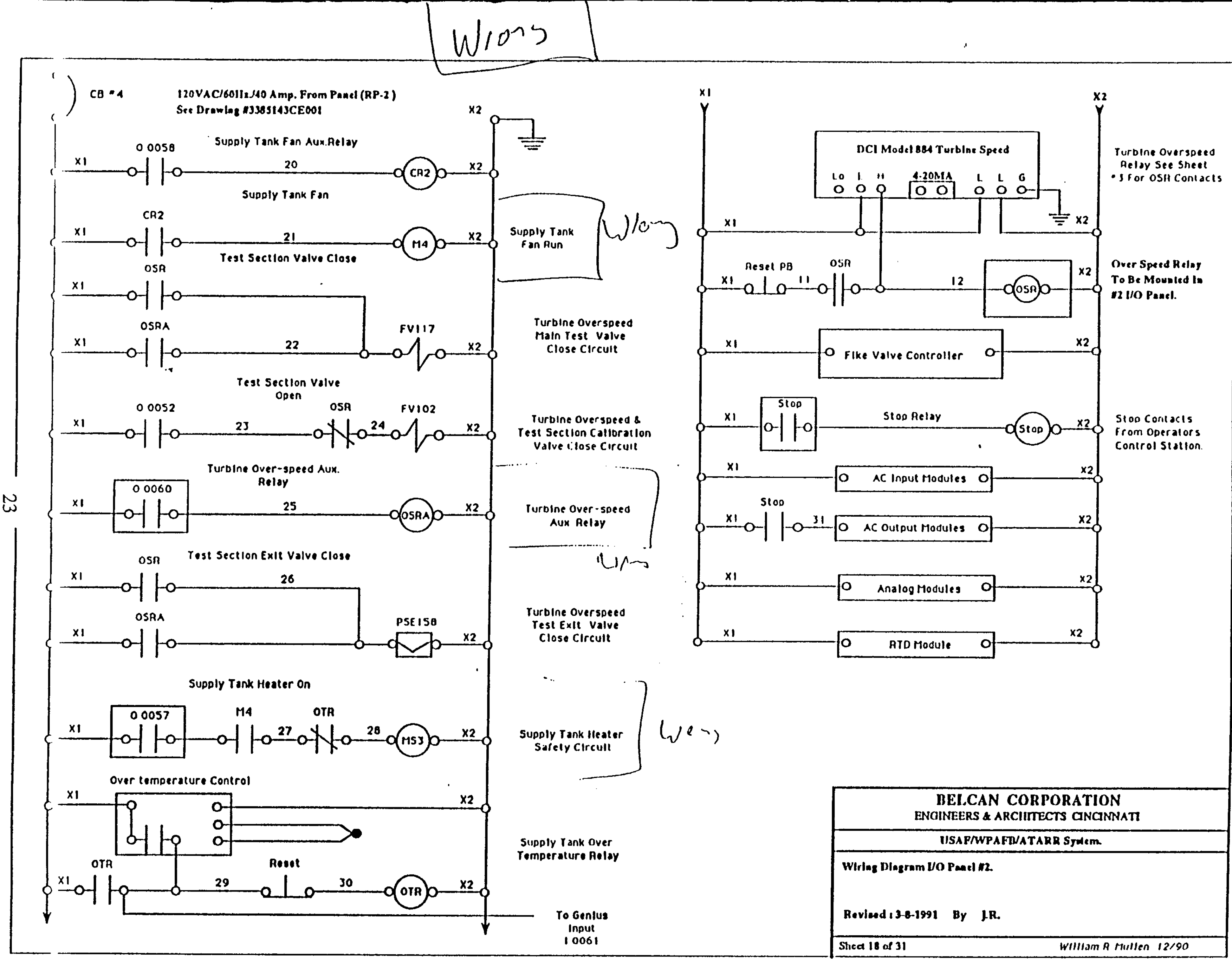
USAF/WPAFB/ATARR System.

Panel Layout I/O Station #2.

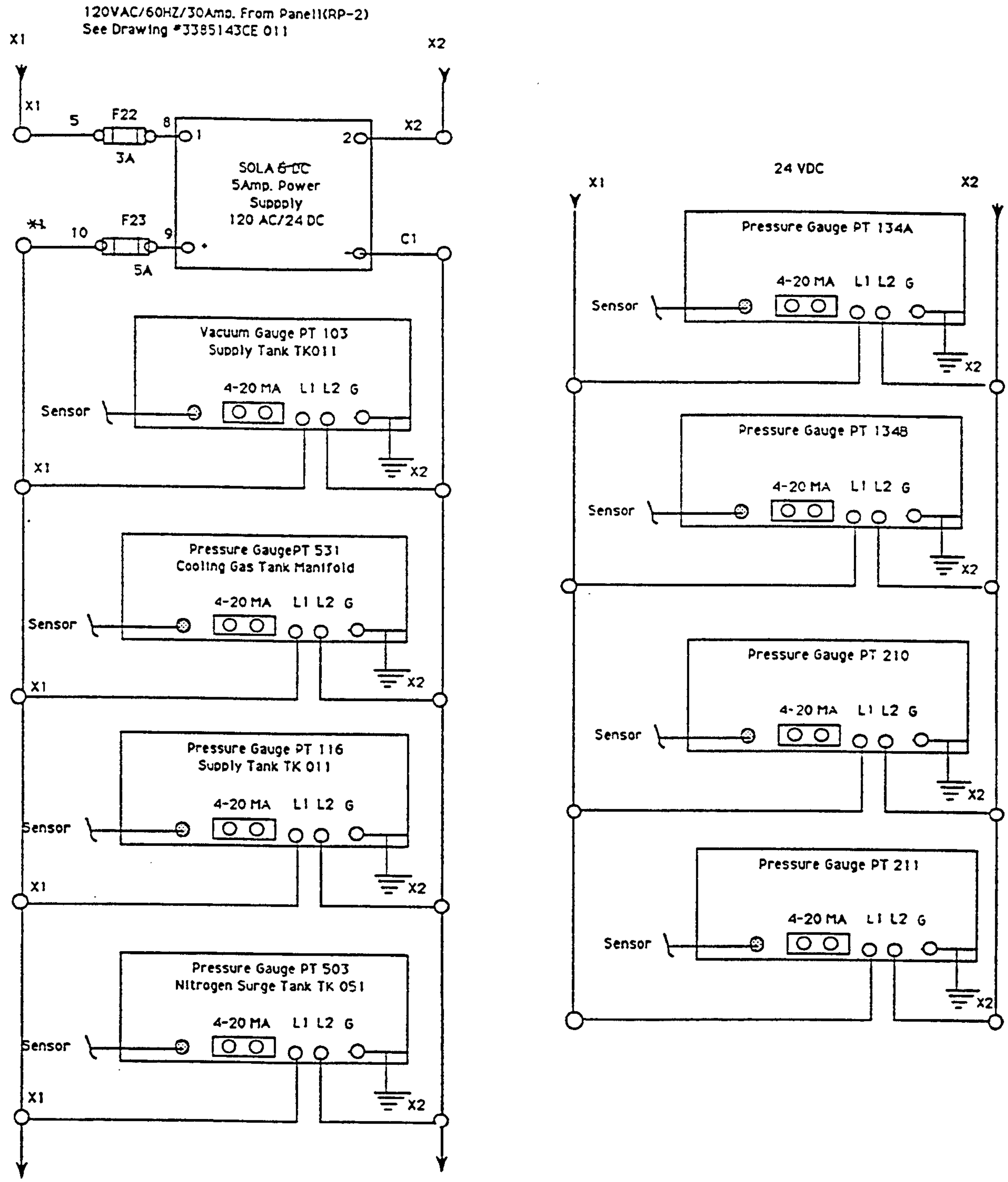
Revised : 3-8-1991 By J.R.

Sheet 17 of 31

William R. Mullen 12/90



CB #4
120VAC/60Hz/40 Amp. From Panel (RP-2)
See Drawing #3385143CE001
Supply Tank Fan Aux.Relay
0 0058
20
CR2
Supply Tank Fan
CR2
21
M4
Test Section Valve Close
OSR
OSRA
22
FV117
Test Section Valve Open
0 0052
23
OSR
24
FV102
Turbine Over-speed Aux. Relay
0 0060
25
OSRA
Test Section Exit Valve Close
OSR
26
OSRA
PSE158
Supply Tank Heater On
0 0057
M4
27
OTR
28
M53
Over temperature Control
OTR
29
Reset
30
OTR
X1
X2
Supply Tank Fan Run
Turbine Overspeed Main Test Valve Close Circuit
Turbine Overspeed & Test Section Calibration Valve Close Circuit
Turbine Over-speed Aux Relay
Turbine Overspeed Test Exit Valve Close Circuit
Supply Tank Heater Safety Circuit
Supply Tank Over Temperature Relay
To Genius Input I 0061
DCI Model 884 Turbine Speed
Lo L H
4-20MA
L L G
Turbine Overspeed Relay See Sheet #3 For OSR Contacts
Reset PB
11
OSR
12
OSR
Over Speed Relay To Be Mounted In #2 I/O Panel.
Fike Valve Controller
Stop
Stop Relay
Stop
Stop Contacts From Operators Control Station.
AC Input Modules
Stop
31
AC Output Modules
Analog Modules
RTD Module
BELCAN CORPORATION
ENGINEERS & ARCHITECTS CINCINNATI
USAF/WPAFB/ATARR System.
Wiring Diagram I/O Panel #2.
Revised : 3-8-1991 By J.R.
Sheet 18 of 31
William R Mullen 12/90



BELCAN CORPORATION

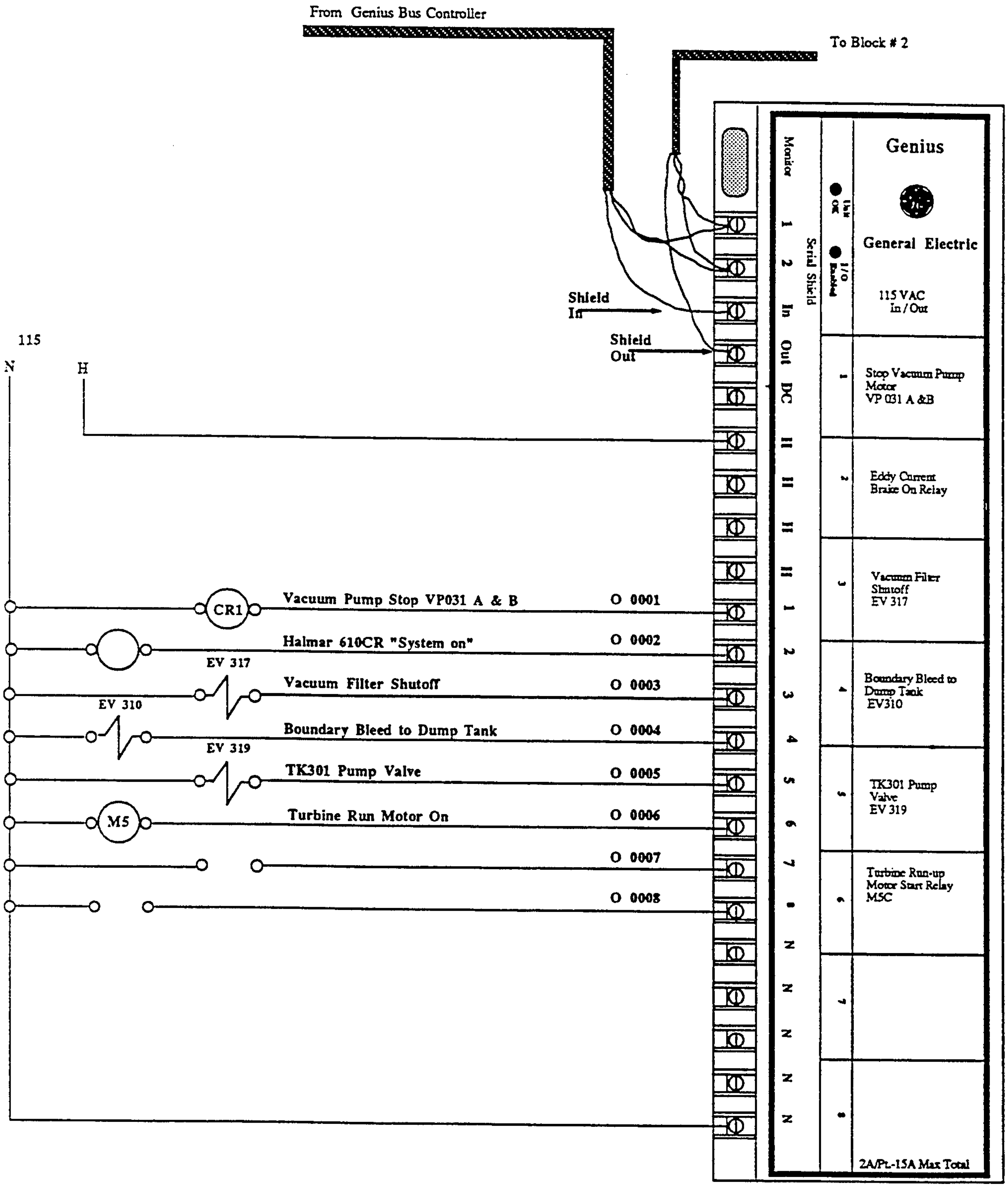
ENGINEERS & ARCHITECTS CINCINNATI

USAF/WPAFB/ATARR System.

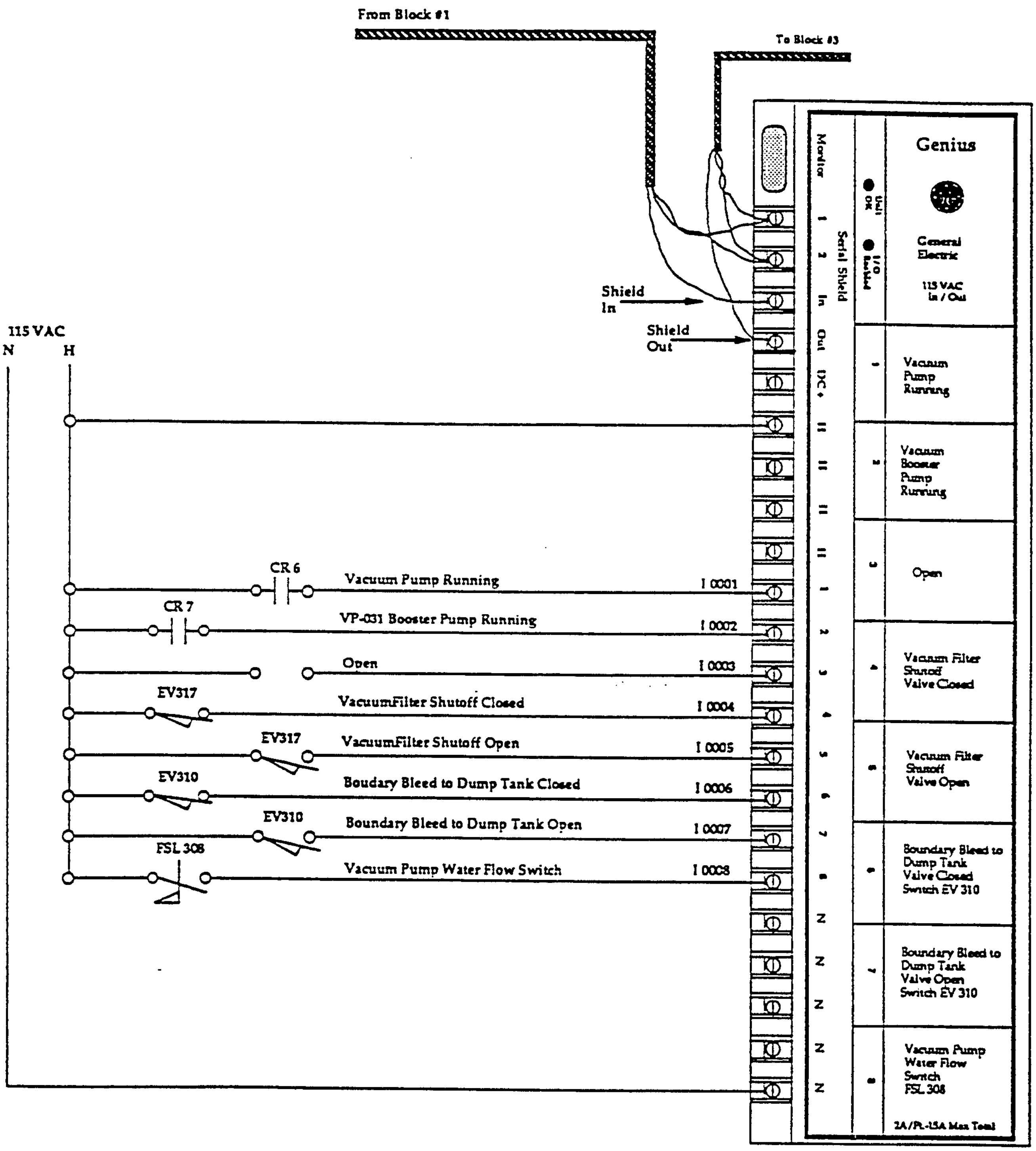
Wiring Diagram I/O Panel #2.

Revised : 3-8-1991 By J.R.

Sheet 19 of 31 William R. Mullen 12/90

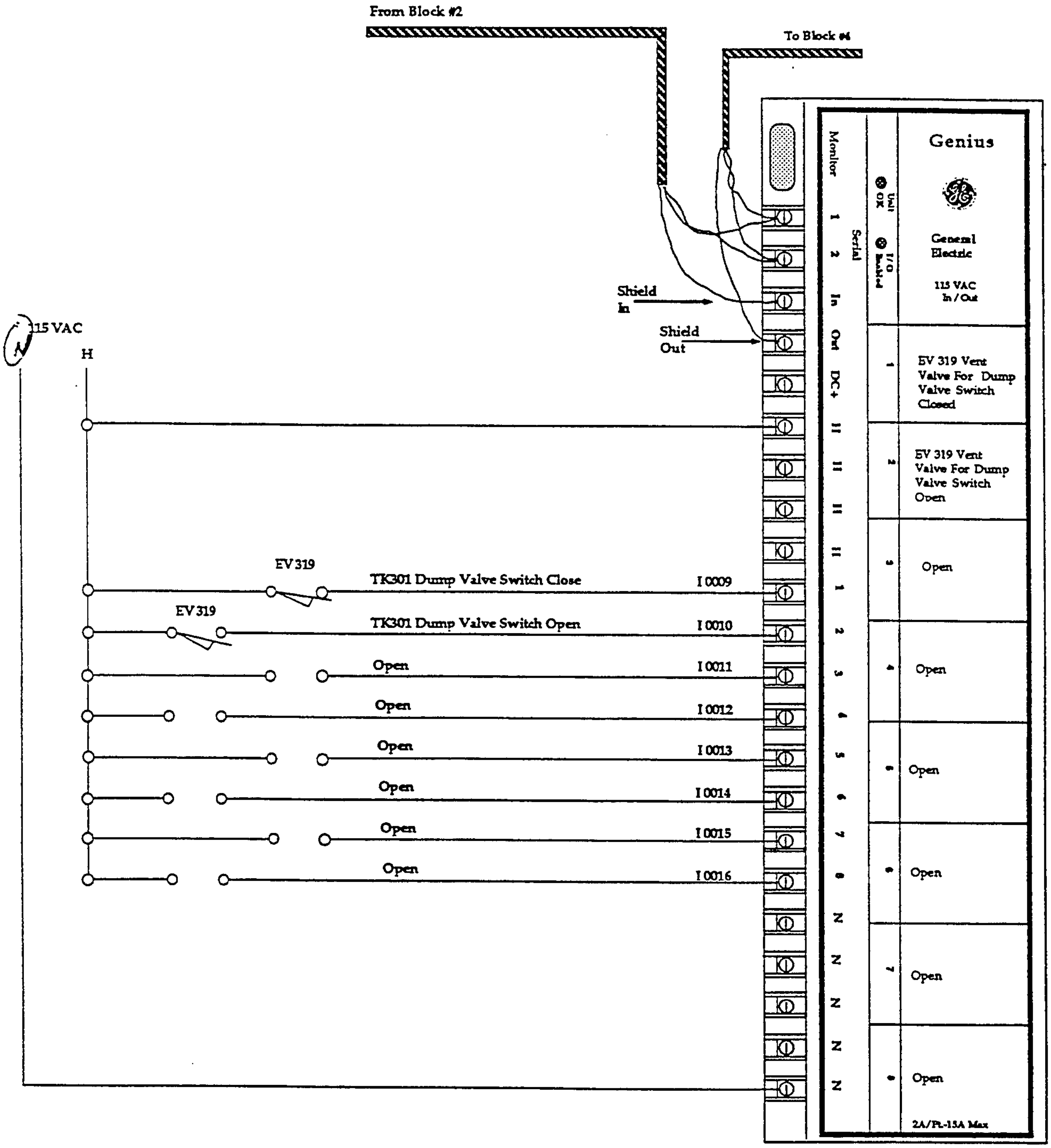


Calspan Corporation	BELCAN ENGINEERS & ARCHITECTS CINCINNATI
Modified according to Paul Fuller	Genius I / O (115 VAC Type) Block #1 Located At Dump Tank
4-28-93 C. Haldeman	Sheet #13 of 31 — W.R. Mullen 12 / 90



BELCAN CORPORATION
ENGINEERS & ARCHITECTS CINCINNATI

Genius I / O (115 VAC Type)
Block #2,Located At Dump Tank 031A
Sta #1 I/O Box
Revised: 3-8-1991 By J.R.
Sheet # 14 of 31 W.R. Mullen 12/90

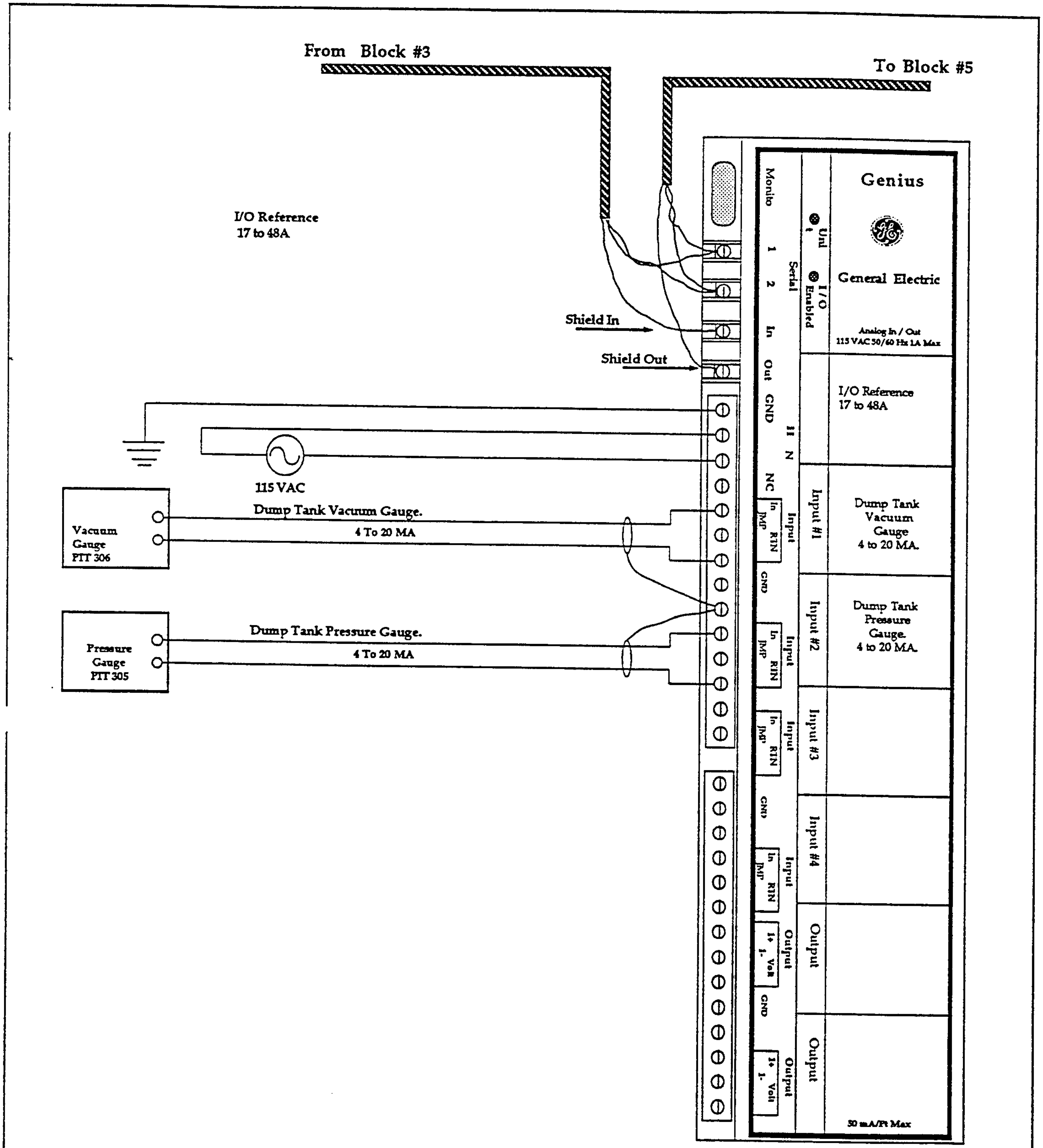


BELCAN CORPORATION
ENGINEERS & ARCHITECTS CINCINNATI

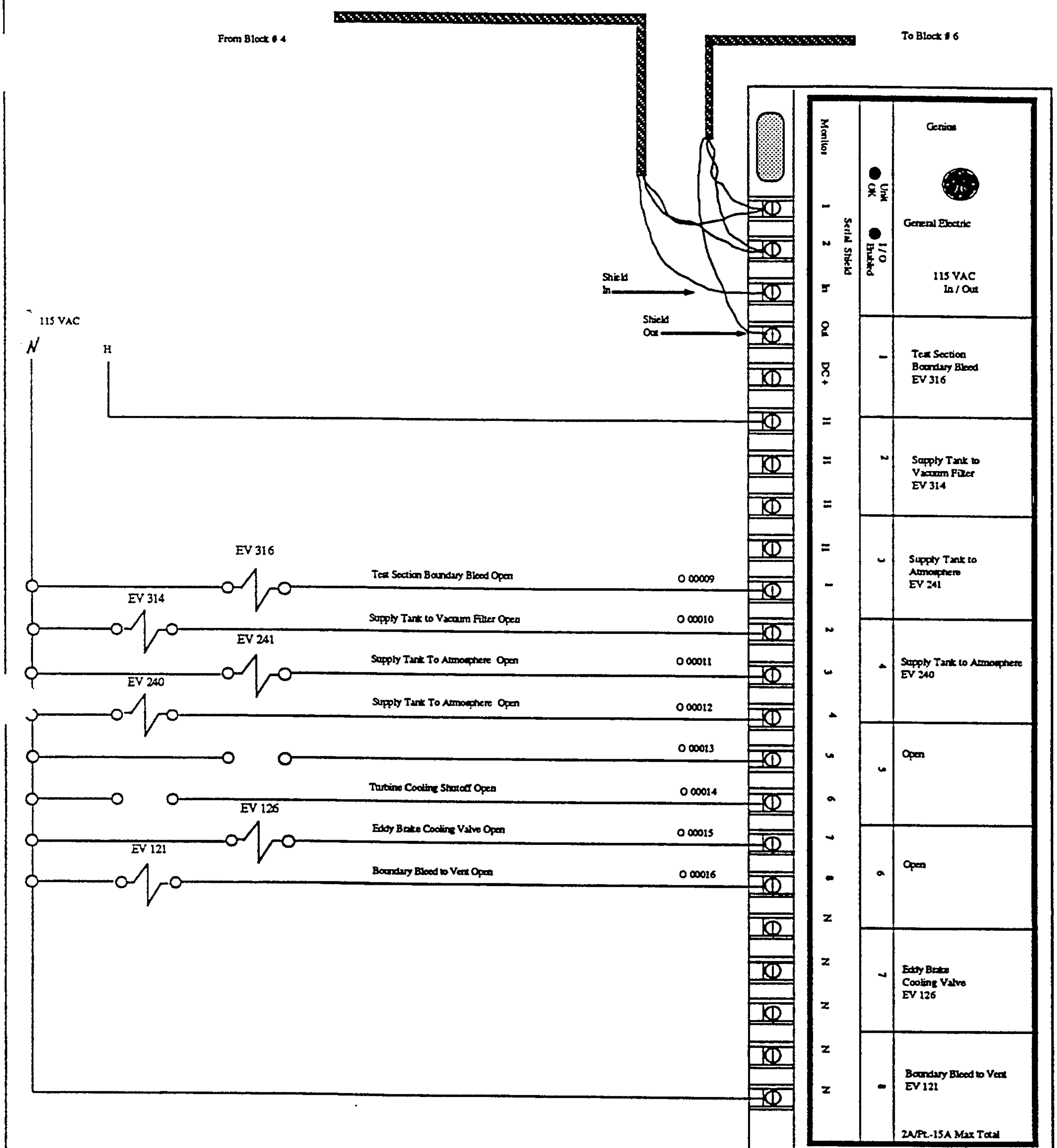
Genius I / O (115 VAC Type)
Block #3, Located At Dump Tank 031A
Sta.#1 I/O Box

Revised: 3-8-1991 By J.R.

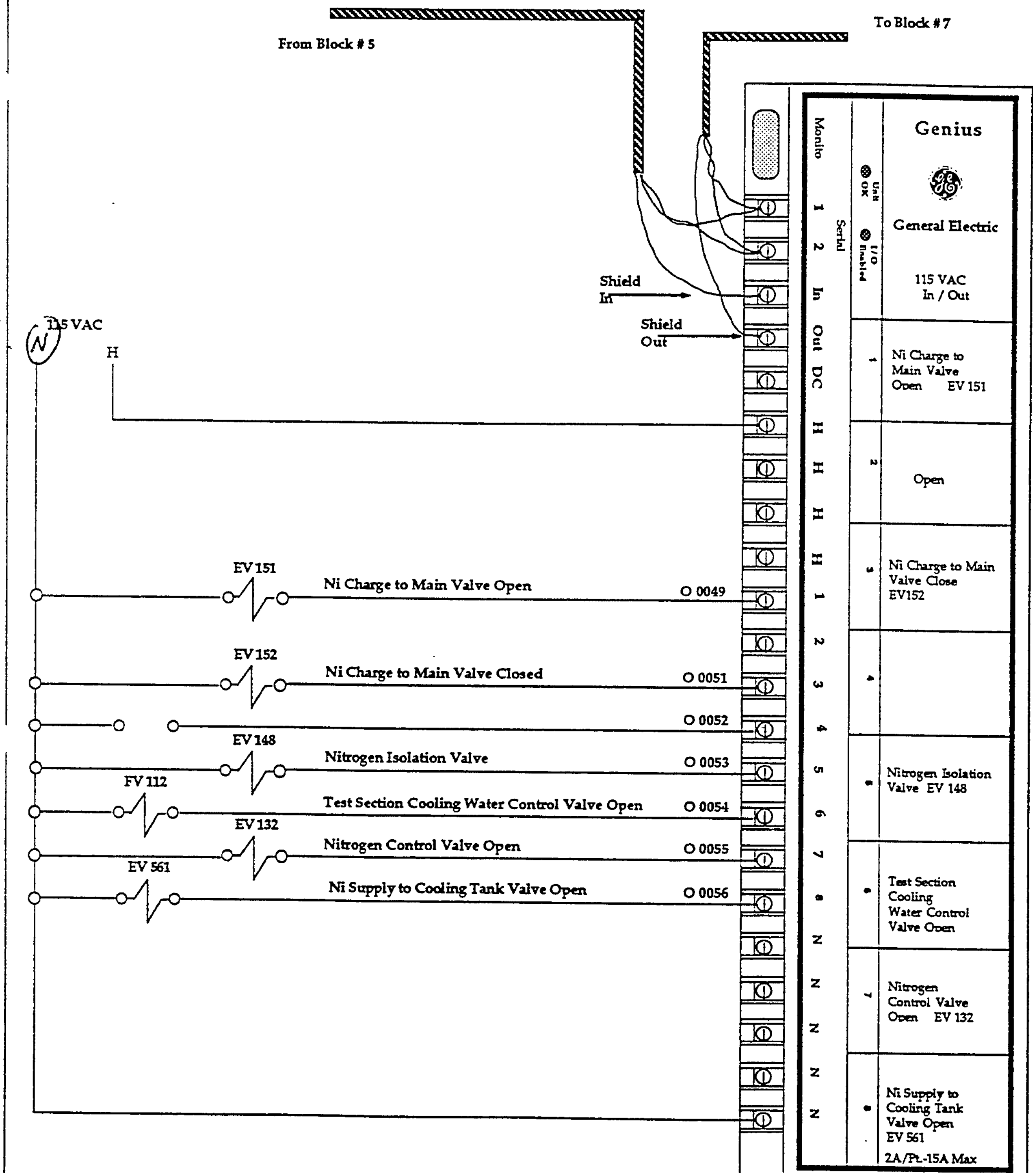
Sheet # 15 of 31 W.R. Mullen



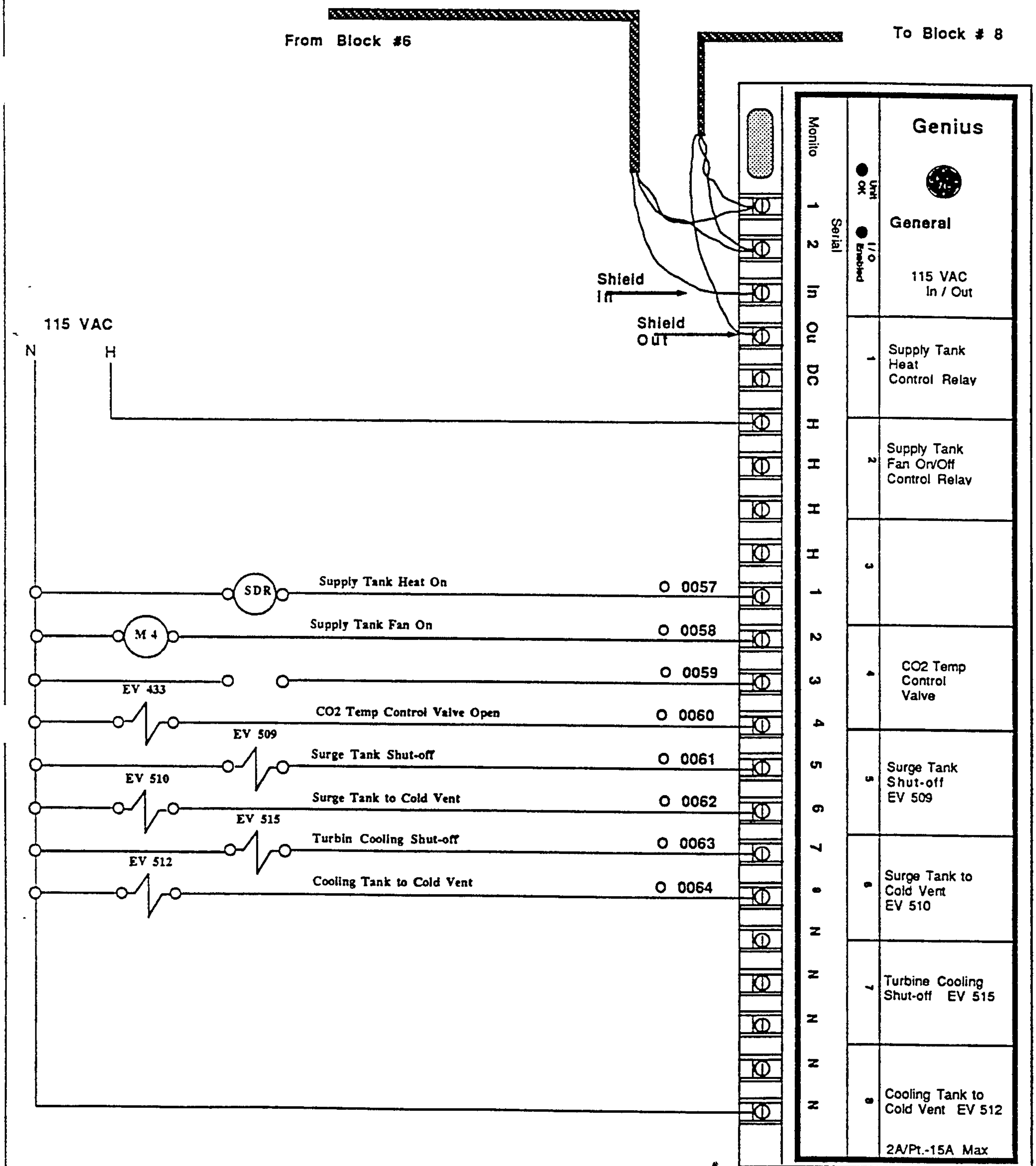
Calspan Corp	BELCAN CORPORATION ENGINEERS & ARCHITECTS CINCINNATI
Removed Cooling Gas Manifold Gauge Revised 8-19-92 C. Haldeman	Genius I / O (115 VAC / Analog Type) Block # 4 Located At Station #1, at Dump Tank. Revised : 3-8-1991 By J.R.
	Sheet 16 of 31 W.R. Mullen



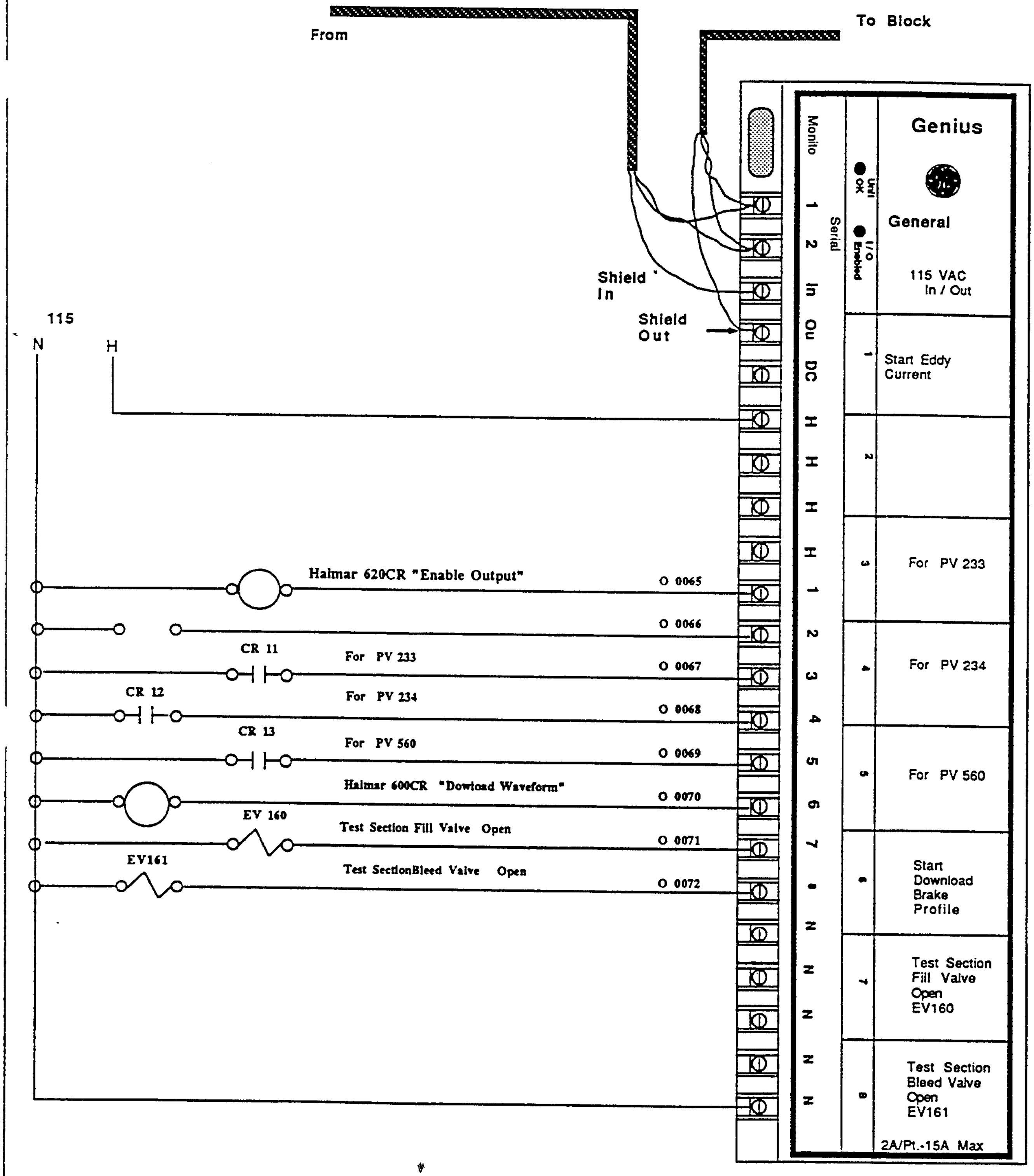
Calspan Corporation	BELCAN CORPORATION ENGINEERS & ARCHITECTS CINCINNATI
Modified to show removal of EV 142 and EV 156 4-28-93 C. Haldeman	Genius I / O (115 VAC Type) Block #5 Located At Supply Tank I/O Station Revised : 3-8-1991 By J.R.
	Sheet # 20 of 31 W.R. Mullen 12/90



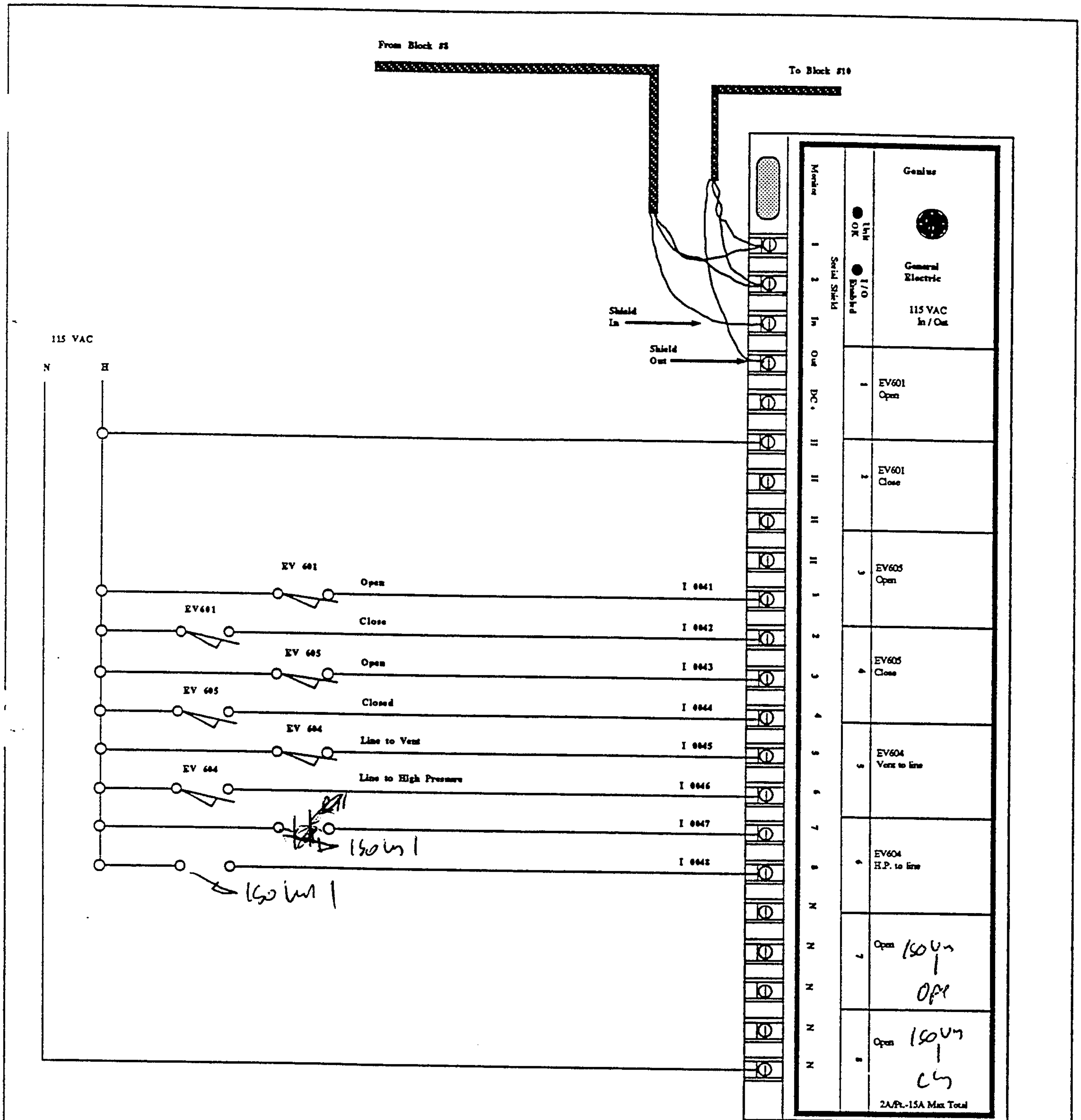
Calspan Corp.	BELCAN CORPORATION ENGINEERS & ARCHITECTS CINCINNATI
Removed FV102 Revised 8-19-92 C. Haldeman	Genius I / O (115 VAC Type) Block #6 Located At Supply Tank I/O Station



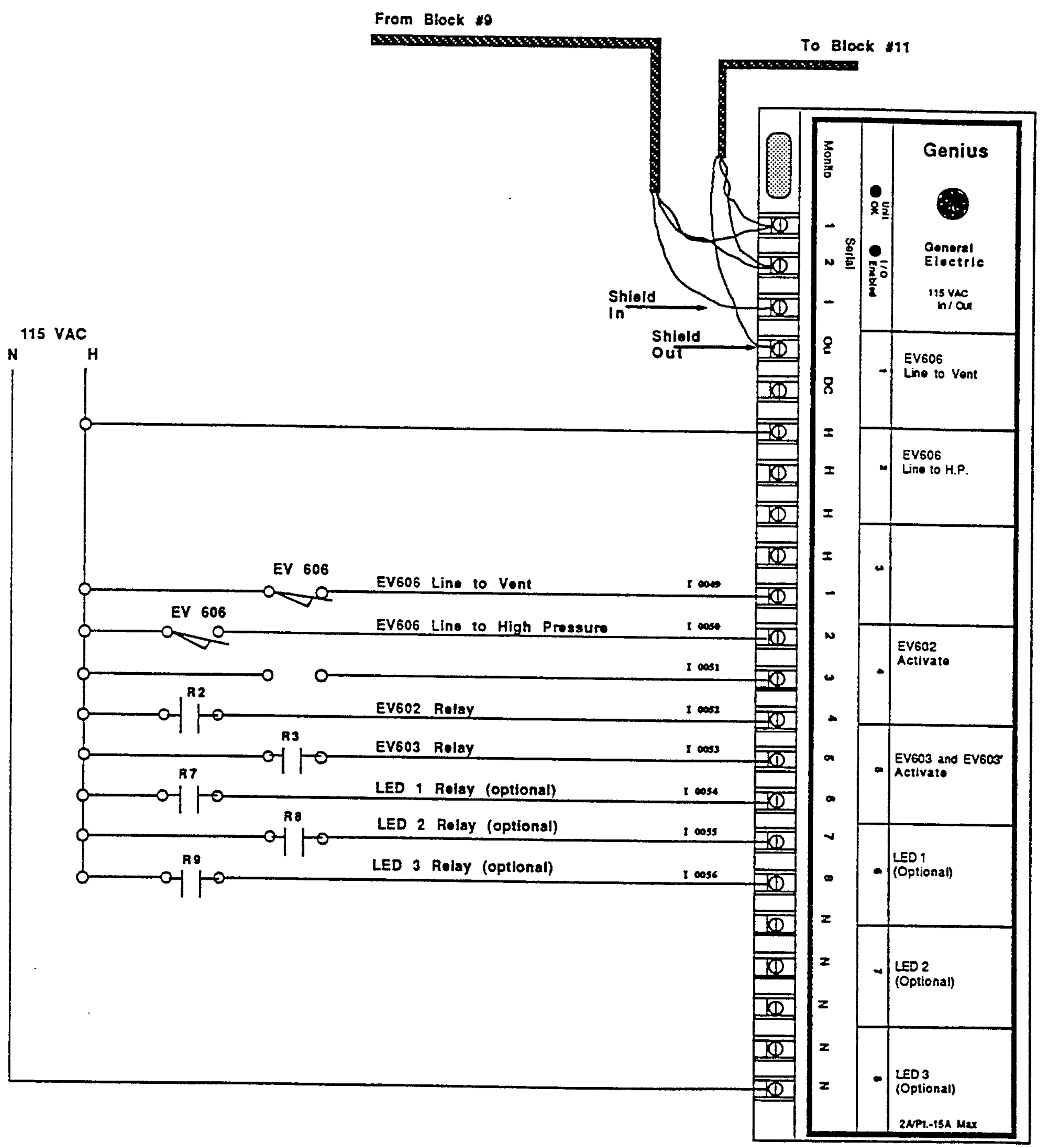
Calspan Corp	BELCAN ENGINEERS & ARCHITECTS CINCINNATI
Removes reference to original main valve activation valves Revised 8-12-92 C. Haldeman	Genius I / O (115 VAC Type) Block #7 Located At Supply Tank I/O
	Sheet # 22 of 31 W.R. Mullen



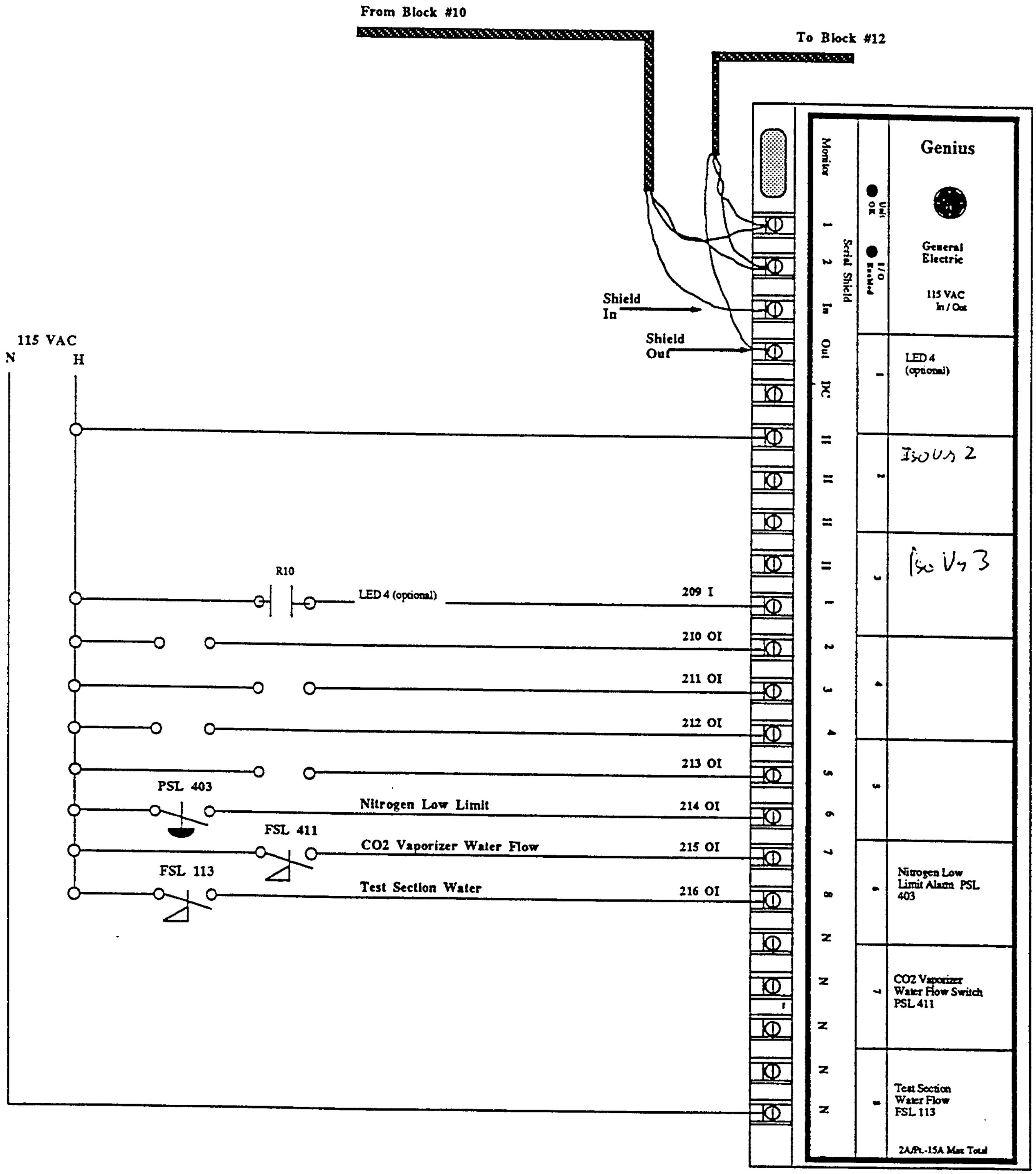
Calspan Corp	BELCAN CORPORATION ENGINEERS & ARCHITECTS CINCINNATI
Removed FV117 Revised 8-19-92	Genius I / O (115 VAC Type) Block #8 Located At Supply Tank I/O Revised : 3-8-1991 By J.R.
	W.R. Mullen 12 / 90



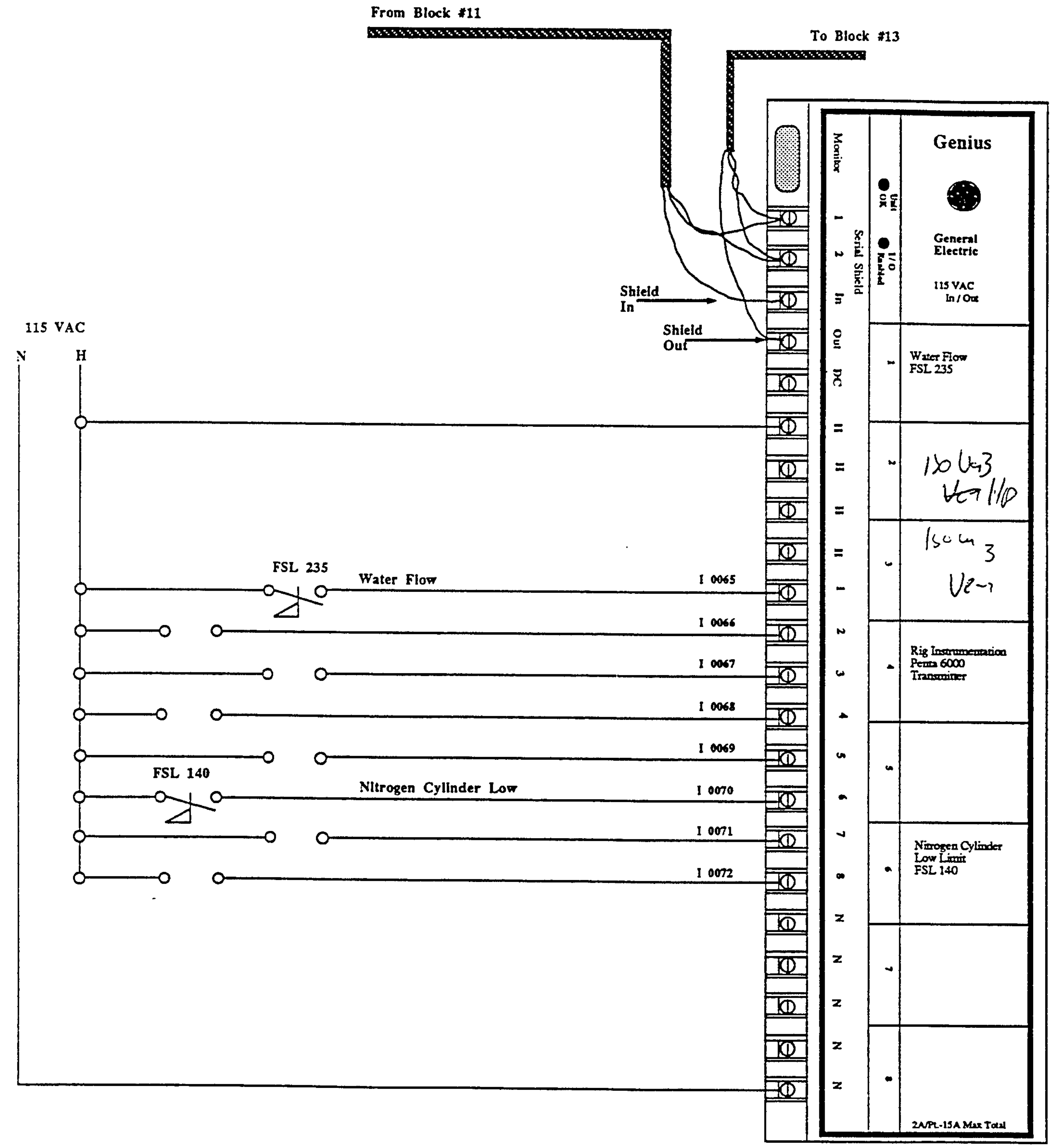
Calspan Corp.	BELCAN CORPORATION ENGINEERS & ARCHITECTS CINCINNATI
Shows position of main valve activation valves Revised 8-19-92 C. Haldeman	Genius I / O (115 VAC Type) Block #9, Located At Supply Tank
	Sheet # 24 of 31 W.R. Mullen 12/90



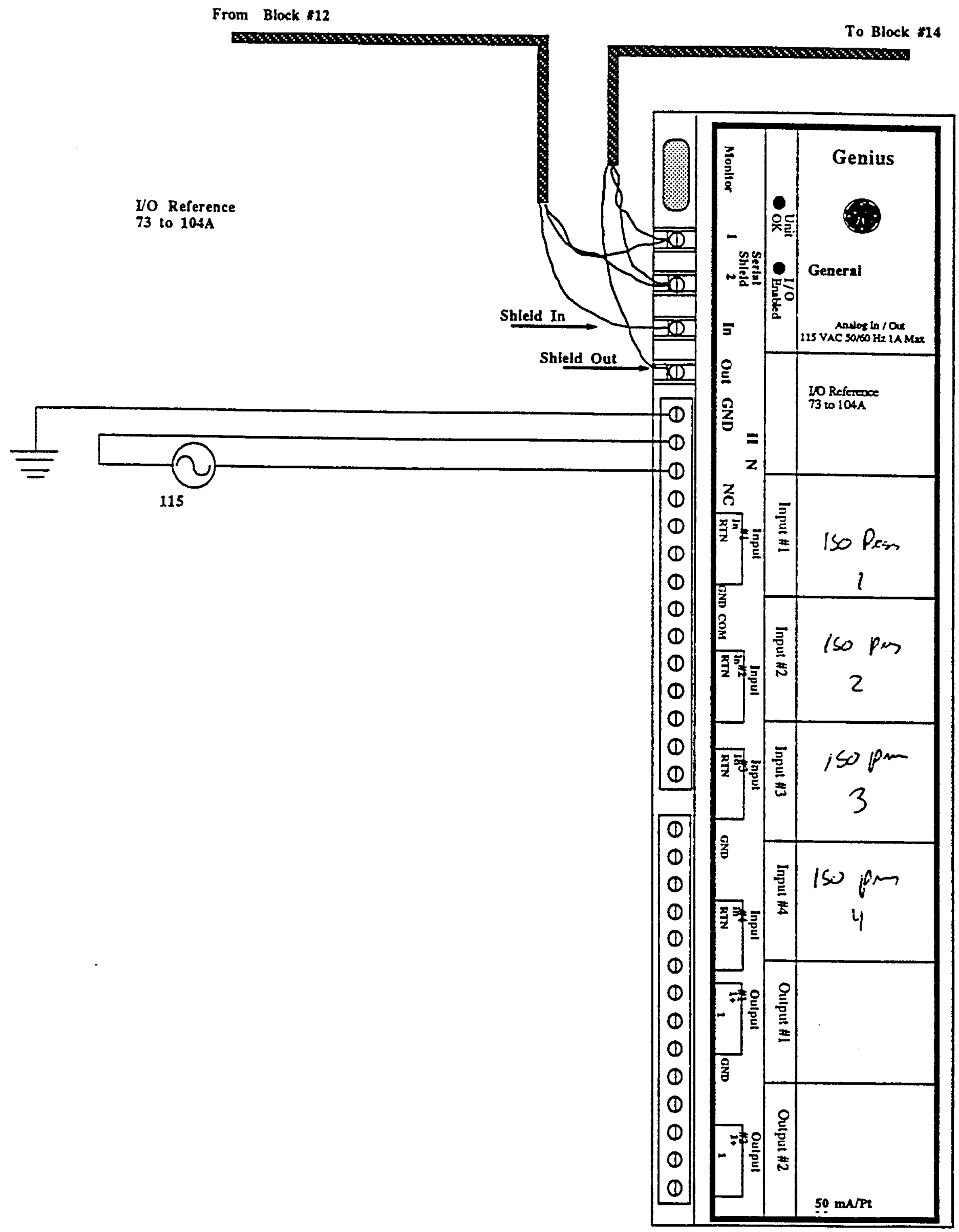
Calspan Corp.	BELCAN CORPORATION ENGINEERS & ARCHITECTS CINCINNATI
Original limit switches were not connected, this block is used for limit switches on the main valve activation system and can be used with the actuator LED relays to provide position information Revised 8-19-29 C. Haldeman	Genius I / O (115 VAC Type) Block # 10 ,Located At Supply Tank Revised : 3-8-1991
	Sheet # 25 *W.R. Mullen*



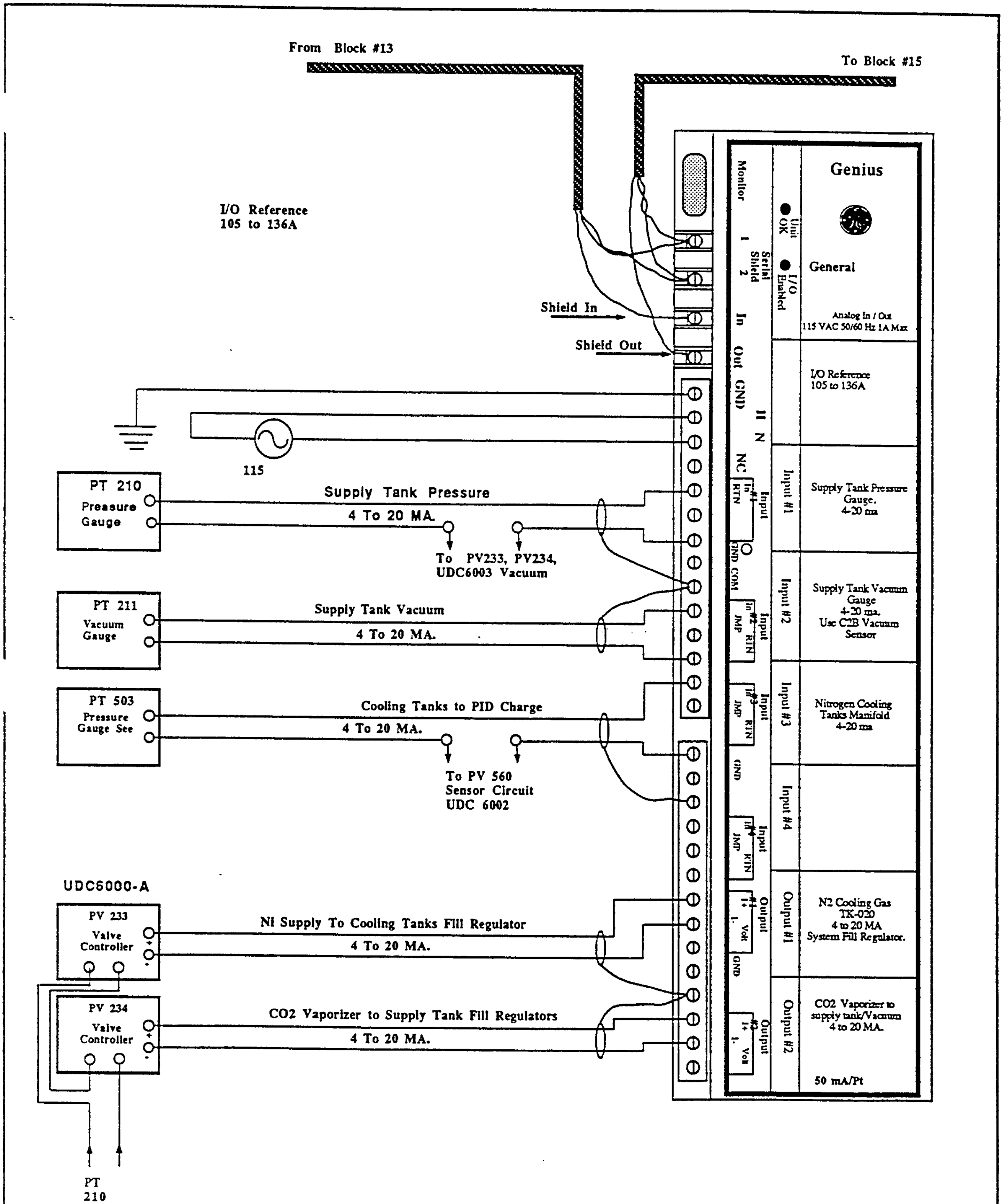
Calspan Corporatior	BELCAN CORPORATION ENGINEERS & ARCHITECTS CINCINNATI
Removed surge tank and cooling tank limit switches references 4-28-93	Genius I / O (115 VAC Type) Block # 11 ,Located At Supply Tank
	Revised : 3-8-1991 By J.R.
	Sheet # 26 of 31 W.R. Mullen 12 / 90



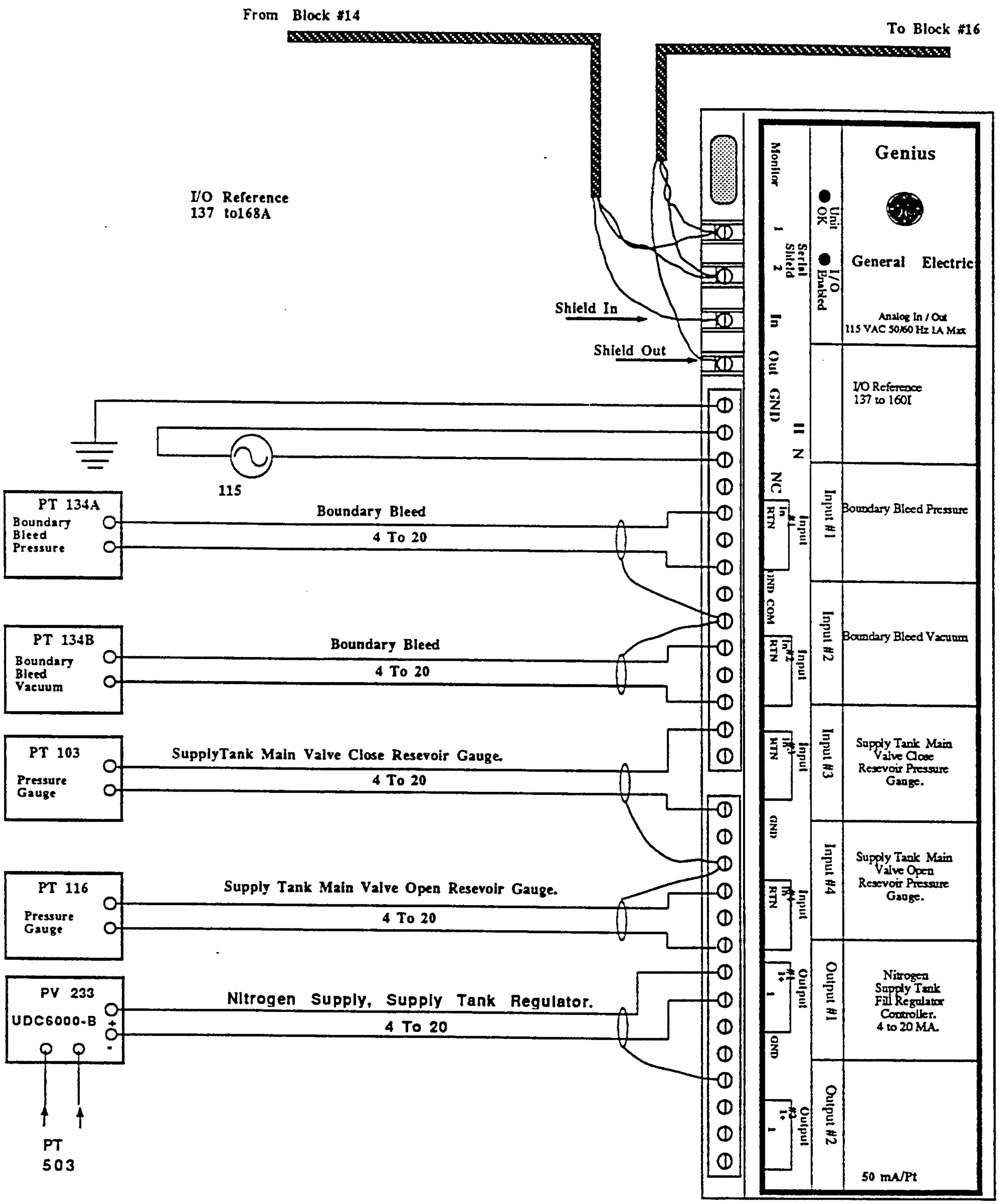
Calspan Corporation	BELCAN CORPORATION ENGINEERS & ARCHITECTS CINCINNATI
Removed references to instrumentation which is not connected 4-28-93	Genius I / O (115 VAC Type) Block # 12 ,Located At Supply Tank I/O Box Revised : 3-8-1991 By J.R.
	Sheet # 27 of 31 W.R. Mullen 12/90



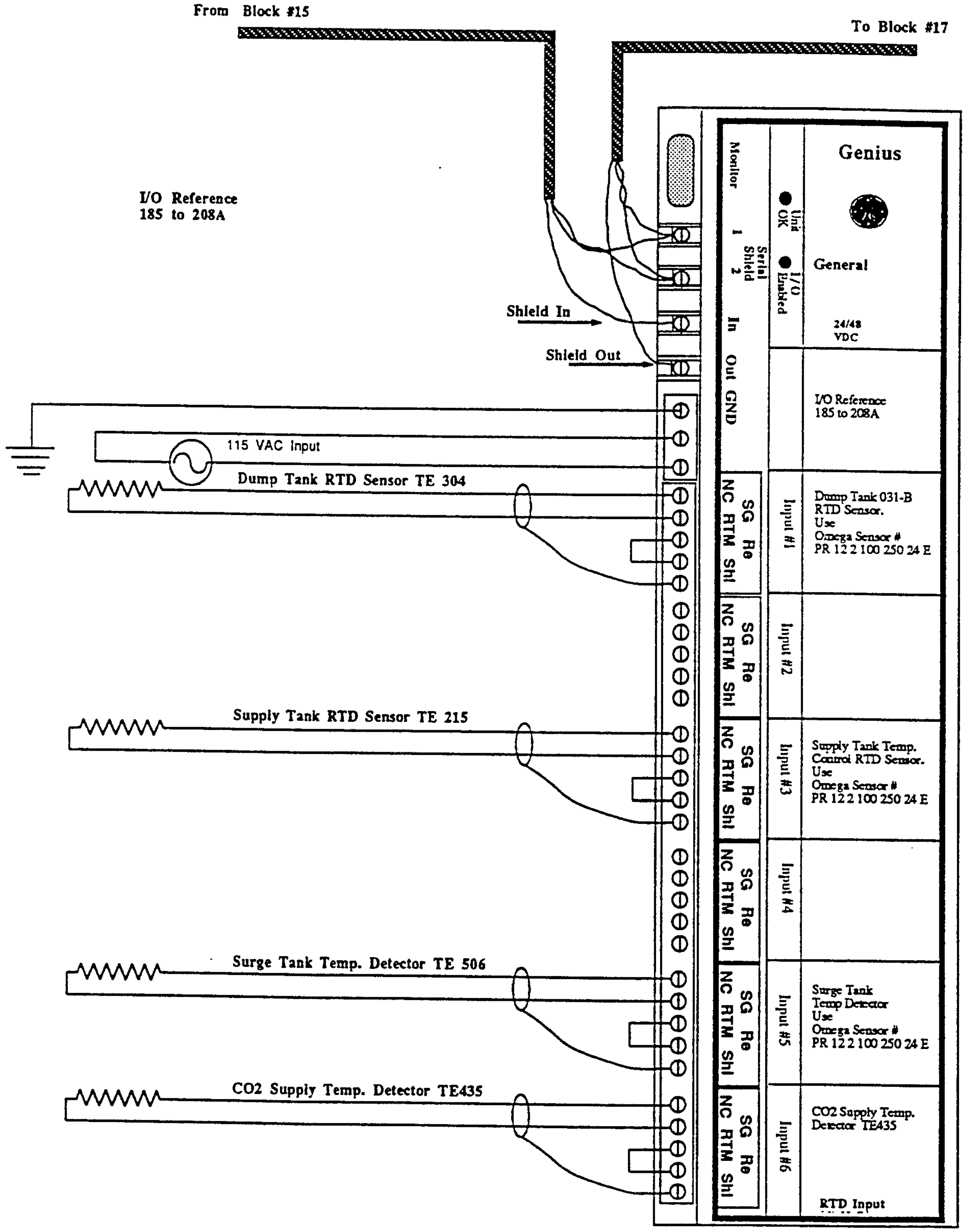
Calspan Corporation	BELCAN ENGINEERS & ARCHITECTS CINCINNATI
Modified to remove bearing instrumentation	Genius I/O (115 VAC / Analog Type) Block # 13 Located At Station #2, Supply Tank
C. Haldeman	Sheet 28 of W.R. Mullen



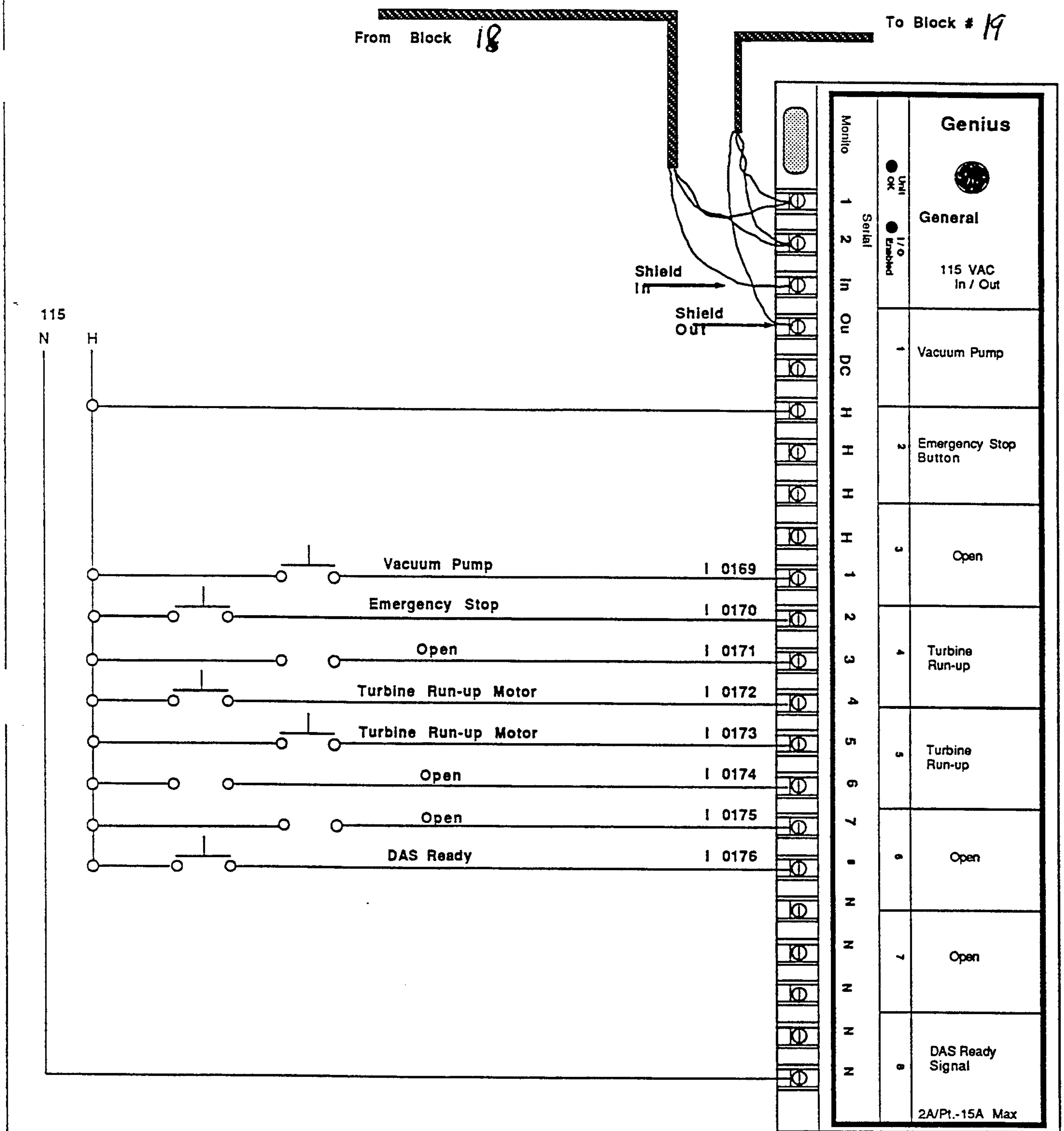
Calspan Corporation	BELCAN ENGINEERS & ARCHITECTS CINCINNATI
Changes made by Paul Fuller are accounted for	Genius I / O (115 VAC / Analog Type) Block # 14 Located At Supply Tank, Station #2
	Revised : 5-6-1991 By
4-28-93 C. Haldeman	Sheet 29 of W.R. Mullen



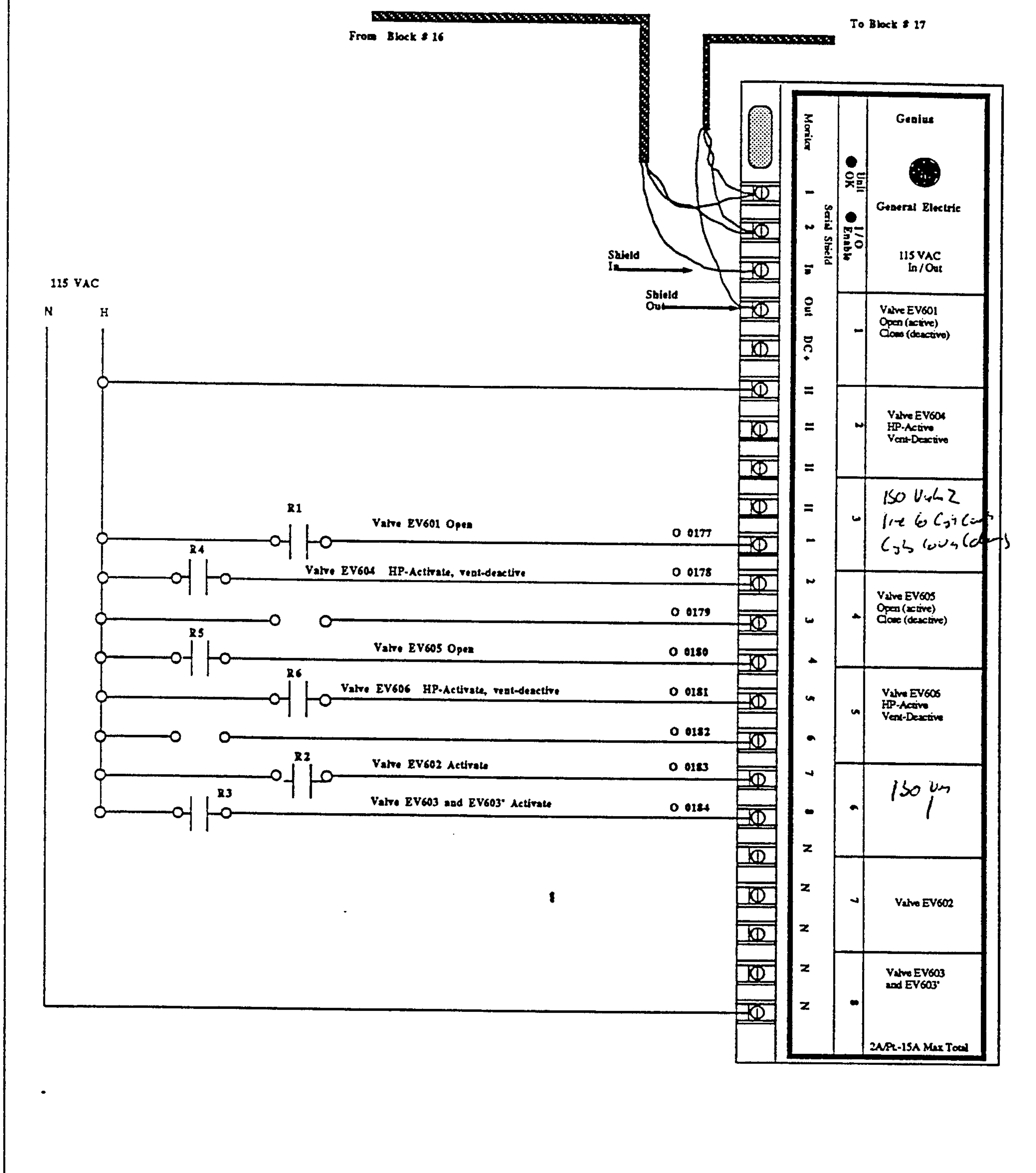
Calspan Corporation	BELCAN ENGINEERS & ARCHITECTS CINCINNATI
Changes made according to Paul Fuller 4-28-93 C. Haldeman	Genius I / O (115 VAC / Analog Type) Block # 15 Located At Supply Tank , Station #2 Revised : 3 8 1991 By J D
	Sheet 30 of 31 *W.R. Mullen 12 / 90*



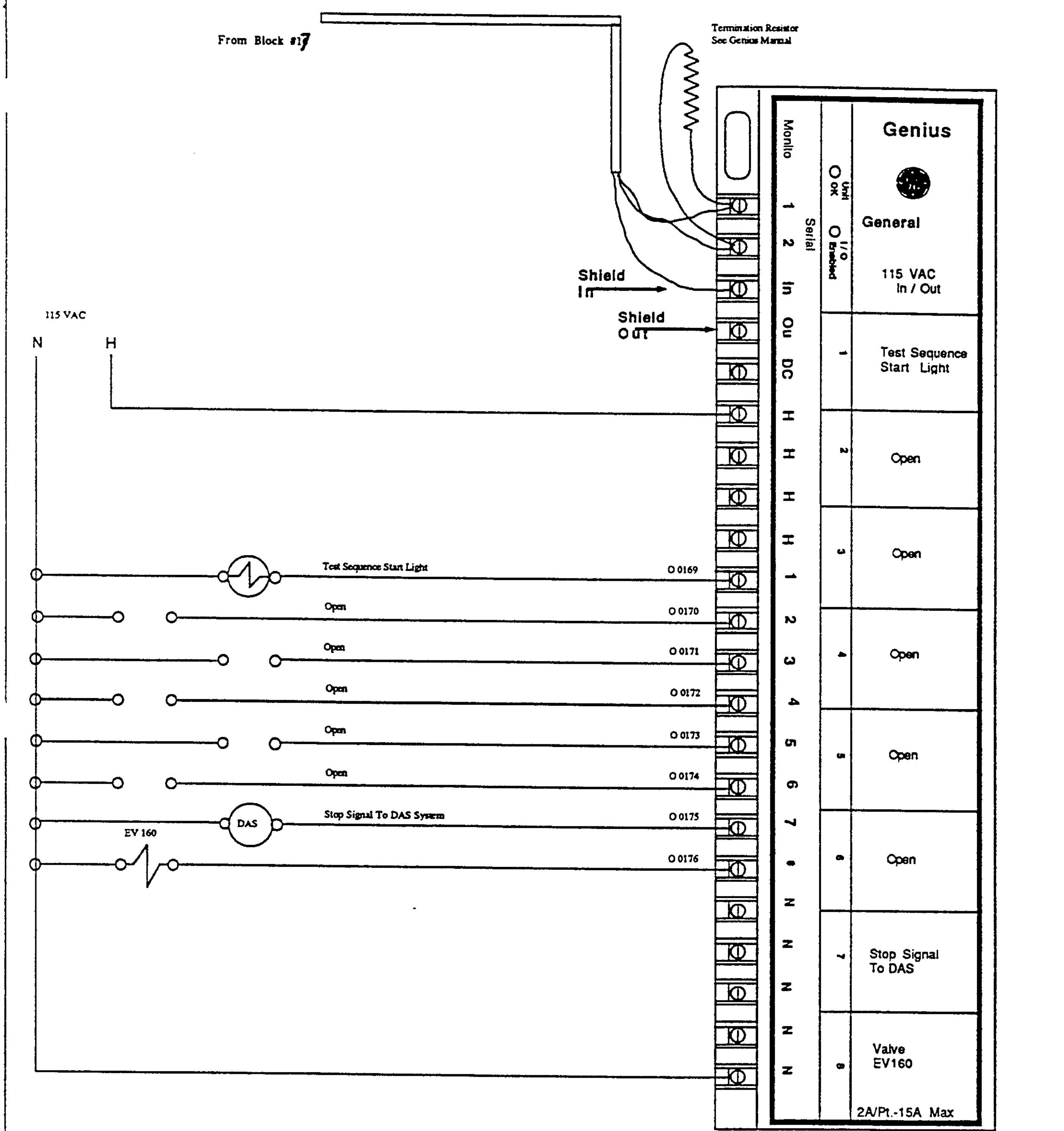
Calspan Corporation	BELCAN ENGINEERS & ARCHITECTS CINCINNATI
Changes per Paul Fuller	Genius I / O RTD Type Block # 16 Located At Supply Tank , Station #2
C. Haldeman	Sheet 31 of 31 W.R. Mullen 12 / 90



Calspan Corp.	**BELCAN** ENGINEERS & ARCHITECTS CINCINNATI
Indicates new connections to other Genius I/O blocks [illegible]	Genius I / O (115 VAC Type) Block #17 Located At Operator Control Station I/O Station #3 Revised : [illegible]
	Sheet # 8 *W.R. Mullen*

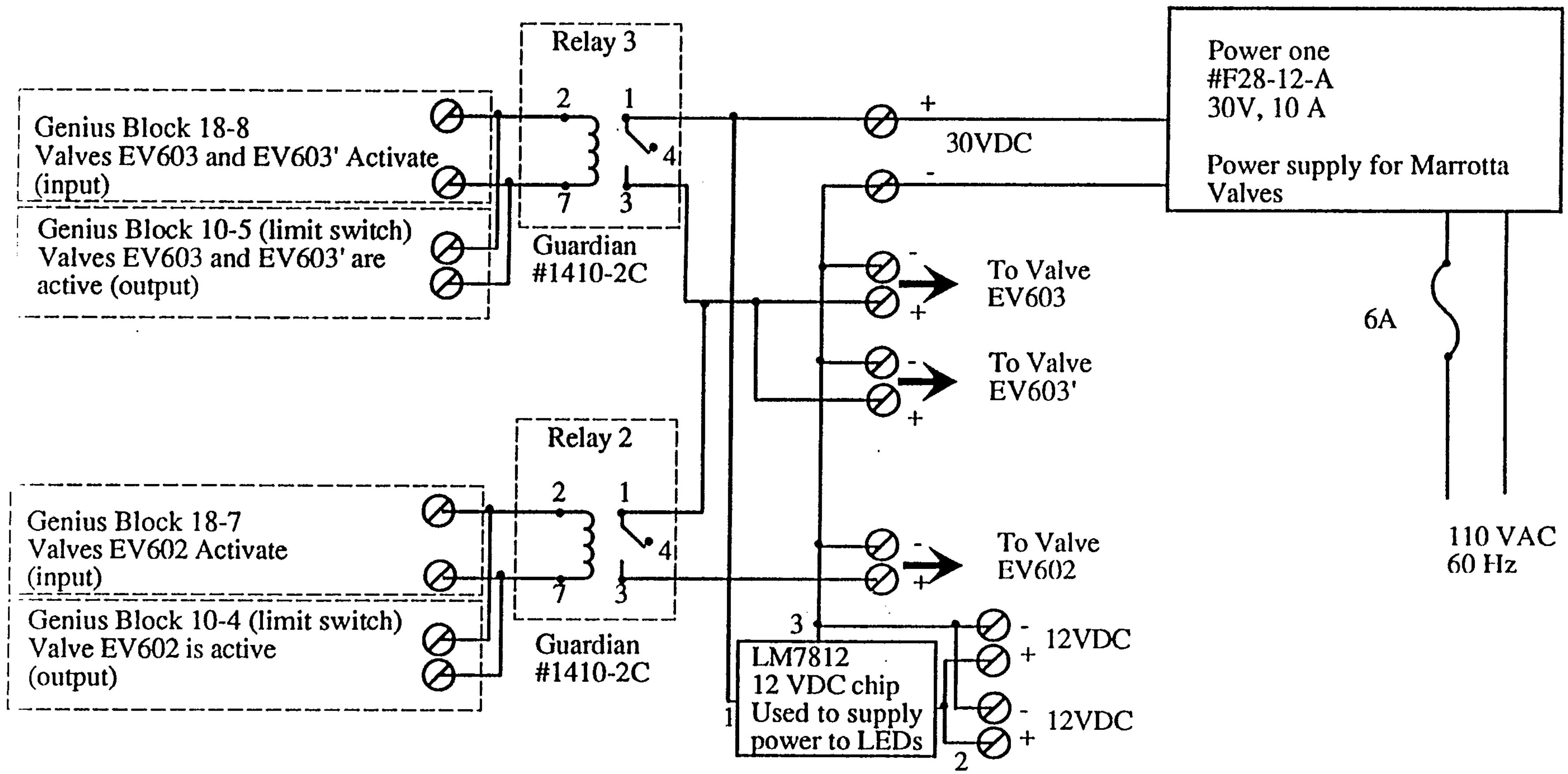


Revision Notes:	Calspan Corporation	BELCAN ENGINEERS & ARCHITECTS CINCINNATI
Block moved from operator control panel to supply tank I/O to run main valve activation system. Control done with spring-loaded relays I/O references renumbered	Genius I / O (115 VAC Type) Block #18 Located At Supply Tank I/O Station	Genius I / O (115 VAC Type) Block #18 Located At Operator Control Station I/O Station #3 Revised : 3-8-1991
	Revised : 8-12-1992 By C. Haldeman	Sheet # 9 W.R. Mullen 12 /



Calspan Corp.	**BELCAN** ENGINEERS & ARCHITECTS CINCINNATI
Indicates new connections to other Genius I/O Blocks	Genius I / O (115 VAC Type) Block #19 Located At Operators Control Panel Revised : 3-8-1991 By J.R.
	W.R. Mullen 12 / 90

Genius I/O Connections

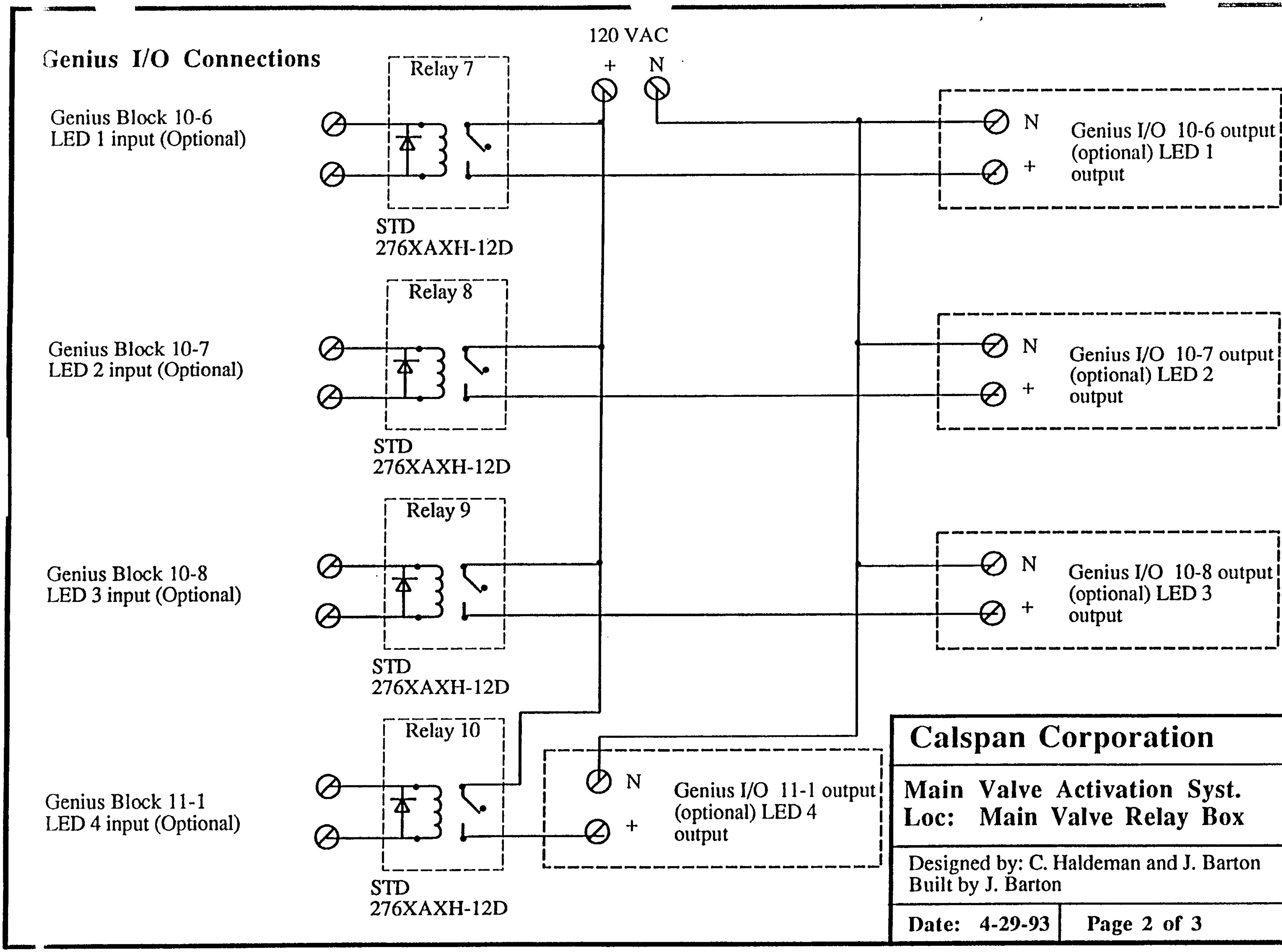


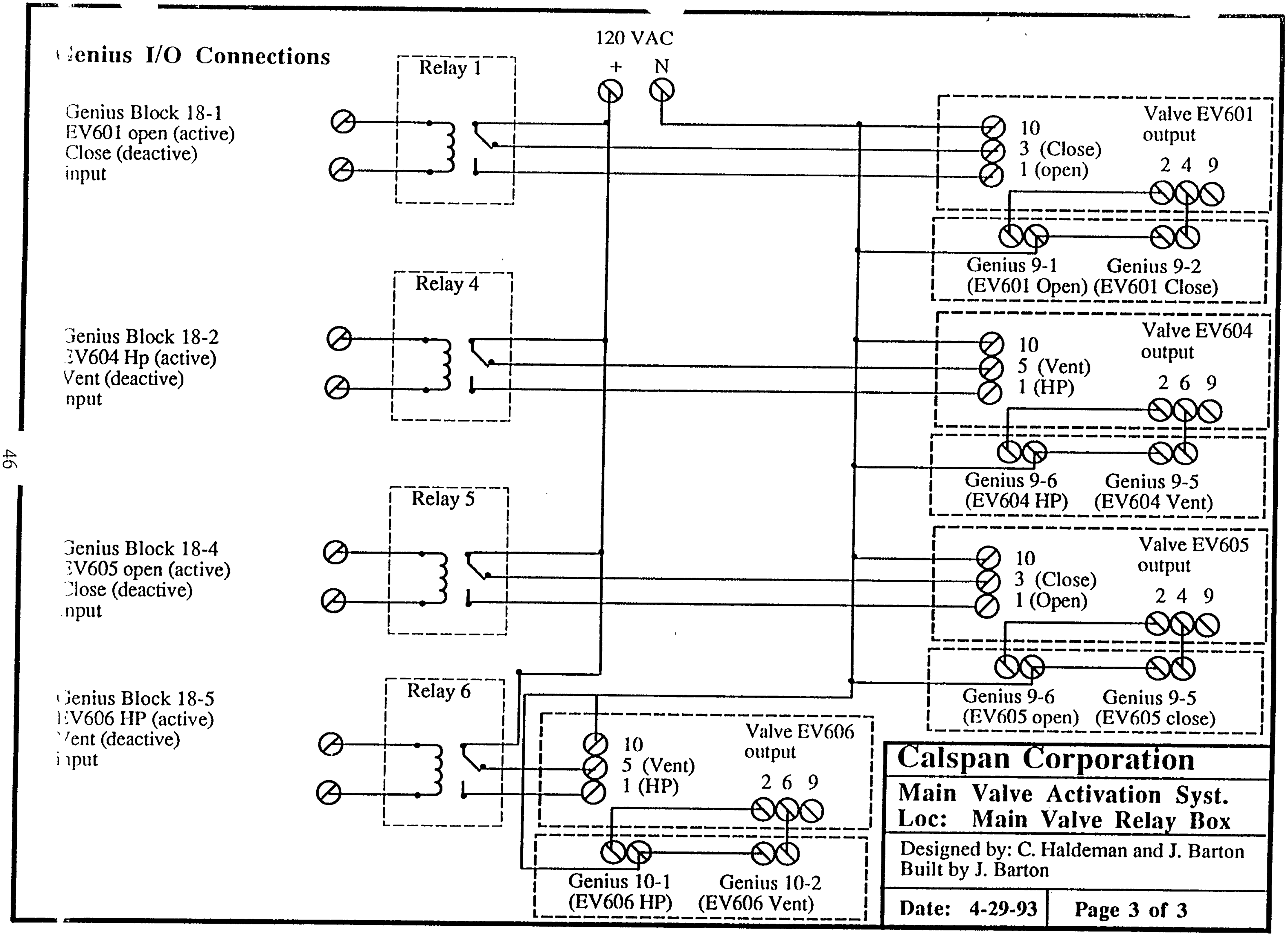
Calspan Corporation

Marrota Control Circuit
Loc: Main Valve Relay Box

Designed by: C. Haldeman and J. Barton
Built by J. Barton

Date: 4-29-93 | **Page 1 of 2**


Genius I/O Connections
120 VAC
+
N
Genius Block 10-6
LED 1 input (Optional)
Relay 7
STD
276XAXH-12D
Genius I/O 10-6 output
(optional) LED 1
output
Genius Block 10-7
LED 2 input (Optional)
Relay 8
STD
276XAXH-12D
Genius I/O 10-7 output
(optional) LED 2
output
Genius Block 10-8
LED 3 input (Optional)
Relay 9
STD
276XAXH-12D
Genius I/O 10-8 output
(optional) LED 3
output
Genius Block 11-1
LED 4 input (Optional)
Relay 10
STD
276XAXH-12D
Genius I/O 11-1 output
(optional) LED 4
output
Calspan Corporation
Main Valve Activation Syst.
Loc: Main Valve Relay Box
Designed by: C. Haldeman and J. Barton
Built by J. Barton
Date: 4-29-93
Page 2 of 3


Genius I/O Connections
Genius Block 18-1
EV601 open (active)
Close (deactive)
input
Genius Block 18-2
EV604 Hp (active)
Vent (deactive)
input
Genius Block 18-4
EV605 open (active)
Close (deactive)
input
Genius Block 18-5
EV606 HP (active)
Vent (deactive)
input
Relay 1
Relay 4
Relay 5
Relay 6
120 VAC
+
N
Valve EV601
output
10
3 (Close)
1 (open)
2 4 9
Genius 9-1
(EV601 Open)
Genius 9-2
(EV601 Close)
Valve EV604
output
10
5 (Vent)
1 (HP)
2 6 9
Genius 9-6
(EV604 HP)
Genius 9-5
(EV604 Vent)
Valve EV605
output
10
3 (Close)
1 (Open)
2 4 9
Genius 9-6
(EV605 open)
Genius 9-5
(EV605 close)
Valve EV606
output
10
5 (Vent)
1 (HP)
2 6 9
Genius 10-1
(EV606 HP)
Genius 10-2
(EV606 Vent)
Calspan Corporation
Main Valve Activation Syst.
Loc: Main Valve Relay Box
Designed by: C. Haldeman and J. Barton
Built by J. Barton
Date: 4-29-93
Page 3 of 3

Frost Controls, Inc.
Industrial Drive South
Smithfield, RI 02917
Tel: (401) 232-5150

INSTRUCTION BULLETIN

"C" SHAPED SENSOR - #- EYE-C-50-12

Product Description:

The EYE-C-50-12 is a complete photoelectric system designed for use in a wide variety of non-contact sensing applications. The entire photoelectric system consisting of an LED light source, a photodiode receiver, amplifying circuitry, Schmitt trigger, voltage regulator, and output transistor, is neatly packaged in a "C" shaped, anodized aluminum housing. The "C" shape eliminates the need for added bracketry, plus, eliminates alignment difficulties associated with individual sensors, when small object detection is the objective. This system is capable of detecting objects as small as .012" in diameter with a response time as short as 50 microseconds.

The EYE-C-50-12 has been designed to be driven with low amperage D.C. power sources, which makes the system ideally suited for direct interface with counters, programmable controllers, computers, microprocessors, and custom electronic circuits requiring high/low logic level switching.

Features:

- Self-contained photoelectric system
- *. Detection of .012" Dia. object
- Response time 50 microseconds
- Repeatibility within .001"
- TTL/CMOS compatible
- Rugged construction
- Easy mounting
- No alignment adjusting

Specifications:

- Supply voltage --------12 VDC
- Supply current --------20 milliAmps
- *. Detectable object size .012" Dia.
- Repeatability --------- within .001"
- Output voltage level
  - Logic High----------- 12 VDC illuminated
  - Logic low ----------- 0 VDC darkened
- Output current sink--- 50 milliAmps
- Operating temperature--50° F-150° F

Response time
- Total system ----------50 microSec.
- Rise/Fall -------------200 NanoSec.
- Propagation Delay
  - output Low to High--6.0 MicroSec.
  - output High to Low--2.0 MicroSec.

Operation Mode-----------Dark operated
(The output transistor is energized when the photoreceiver is darkened.)

Specifications:

- Light Source ----GA AL AS infrared LED
- Photoreceiver----Photodiode
- Material --------Blue anodized aluminum
- Cable ---------- 5 conductor 26 AWG 6' long
- Shielding ------ Tinned copper braid
- Weight --------- 3 ounces

* Detectable object size-This system is designed to detect objects of .012" dia. and larger. If smaller object size detection is needed, simply add an external resistor or variable resistor in series with the LED, as shown on wiring diagram (optional). Detection of object sizes as small as .008" dia. are possible.

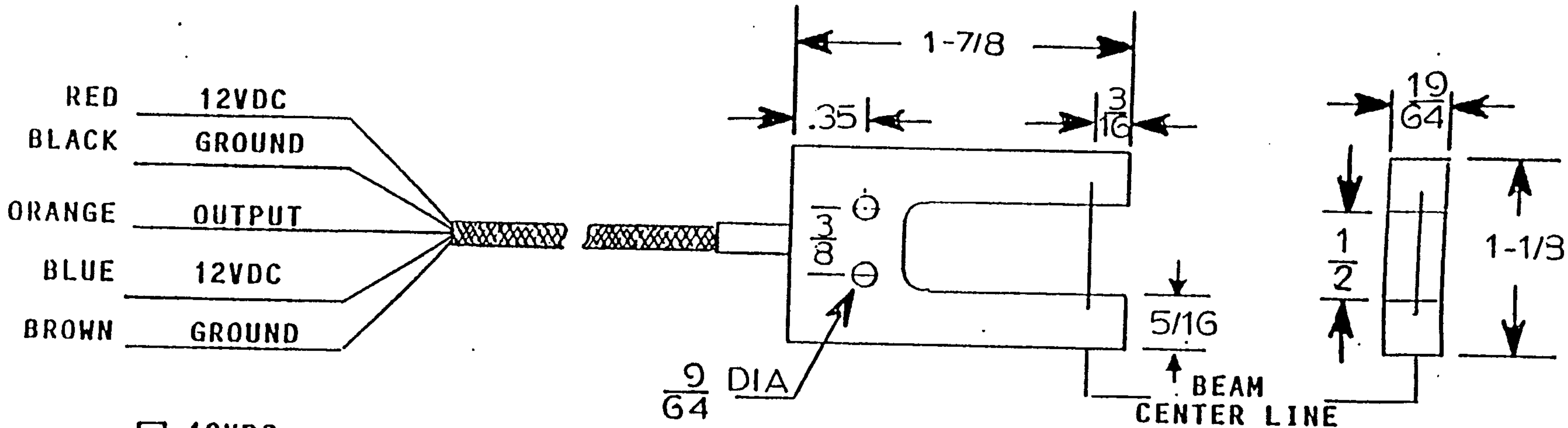
Ambient Light

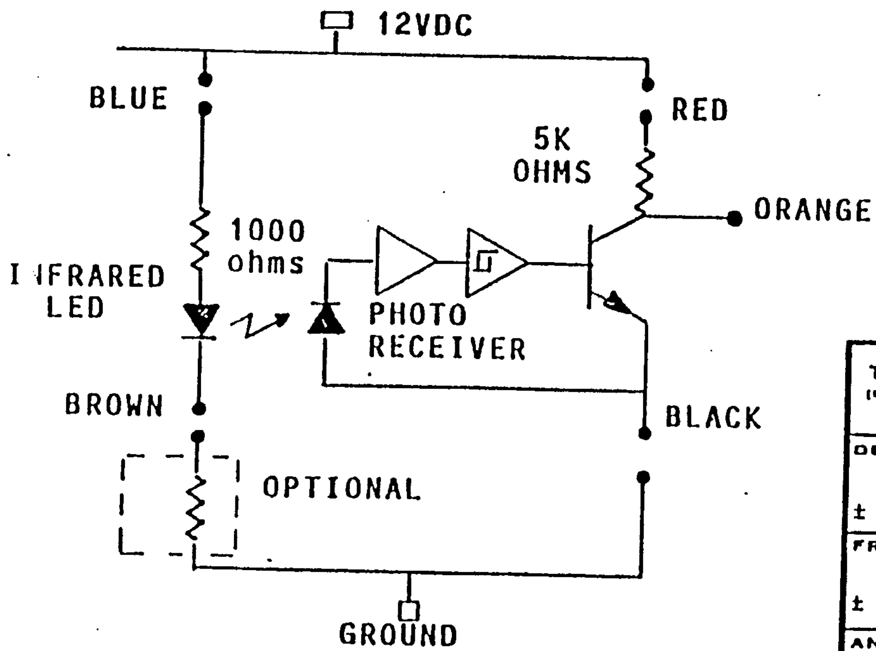
Light sources that contain a great deal of infrared light, such as: sunlight, incandescent lighting and hi-intensity work lamps, should be restricted from shining directly on the photoreceiver orifice, for best results.

ELECTRICAL SPECIFICATIONS

SUPPLY VOLTAGE	12VDC
SUPPLY CURRENT	20 mA
OBJECT SIZE DETECTABLE	.012" DIA.
LOGIC OUTPUT VOLTAGE	0-12 VDC
OUTPUT SINK CURRENT	50 mA

DATE	SYM	REVISION RECORD	TH	DR.





NOTE:
THE PHOTO RECEIVER IS LOCATED ON THE SIDE STAMPED "FROST CONTROLS"

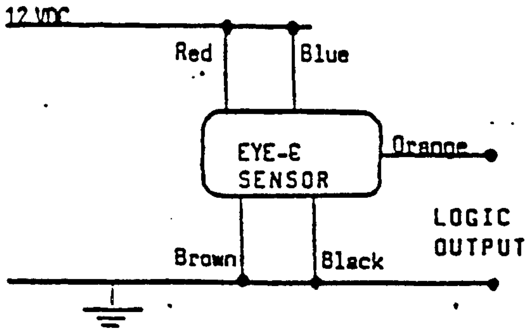
TOLERANCES (EXCEPT AS NOTED)	FROST CONTROLS INC		
DECIMAL ±	WIRING DIAGRAM	SCALE 1:1	DRAWN BY / APPROVED BY
FRACTIONAL ±	TITLE EYE-C-50-12		
ANGULAR ±	DATE 1/86	DRAWING NUMBER 400522	

K+E CRYSTALENE® 10 9465 ENGINEERS' STANDARD FORM

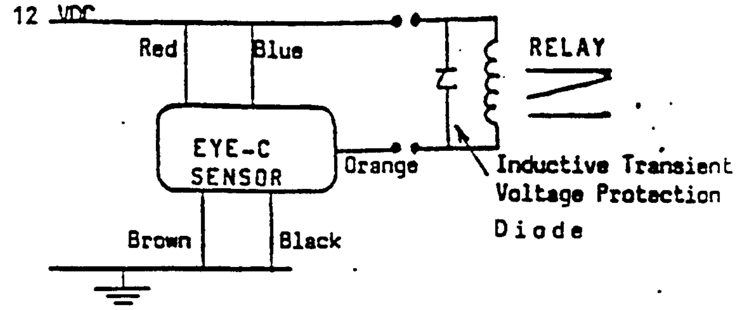
MADE IN U.S.A.

TYPICAL APPLICATIONS

LOGIC OUTPUT

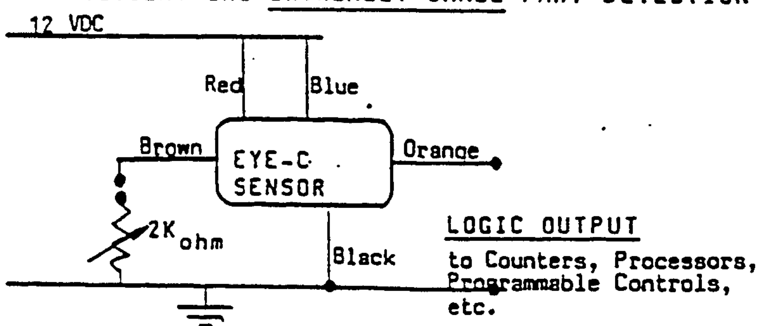


RELAY OUTPUT



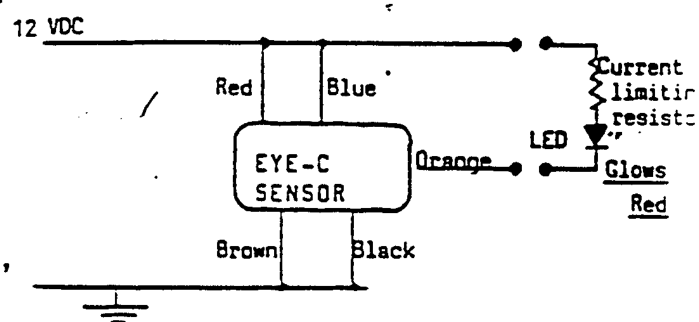
SENSITIVITY ADJUSTMENT

TRANSLUCENT and EXTREMELY SMALL PART DETECTION

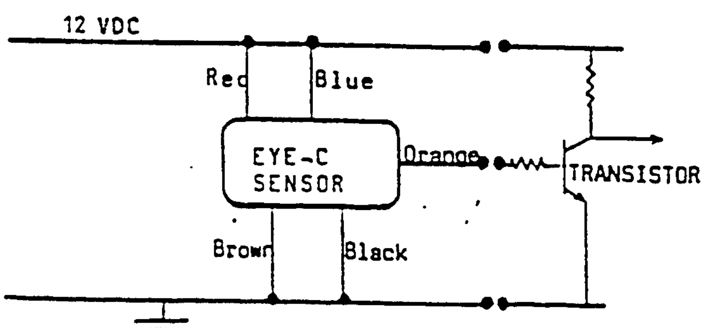


Increase R1 to detect objects less than .012" in diameter.

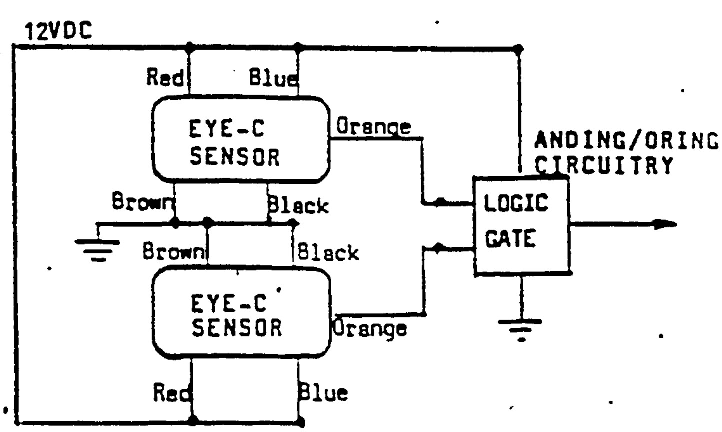
VISIBLE STATUS INDICATION



TRANSISTOR LOGIC



COMBINING MULTIPLE SENSORS



All EYE-C series sensors may be battery operated.

Check control unit manufacturers electrical specifications before interfacing sensors.

Example: Counter's minimum input pulse duration

: LED's maximum current

INTERNATIONAL SERIES DESCRIPTION

The INTERNATIONAL SERIES is a high reliability line of open-frame power supplies designed to operate from the wide range of AC power sources found worldwide.

This feature greatly simplifies your inventory and service considerations by allowing the use of one standard power supply regardless of destination.

Additionally, these models are designed to meet domestic and European regulatory agency requirements.

If you plan to distribute your products worldwide, obtaining necessary agency approvals can be greatly simplified by specifying POWER-ONE, INC. INTERNATIONAL SERIES.

power-one

D.C. POWER SUPPLIES

INTERNATIONAL SERIES DC POWER SUPPLIES

DRAWING NO. 53250 REV G

SPECIFICATIONS AND APPLICATION DATA

VOLTAGE/CURRENT RATING CHART

MODEL	+5V	+12V	+15V	+24V	+28V	-12V	-15V	CASE
HIGH POWER								
F5-25/OVP-A	Δ 25•							F
F15-15-A		Δ 16 or 15						F
F24-12-A				Δ 12 or 10				F
G5-35/OVP-A	Δ 35•							F
CP197-A	Δ 50•							F
TRIPLE								
CC-150W-A	12•	3.4 or 3				3.4 or 3		DCC

DISK DRIVES

MODEL	+5V	+12V	+24V	-5V	-12V			
CP340-A	.5/.7Pk•	.9/1.8Pk						340-A
CP510-A	6.0•	2.5/7.5Pk						510-A
CP384-A	9.0•		2/8Pk	1.2 or 1.2				131
CP379-A	6.0•		3.5/8Pk	1.2 or 1.2				131
CP323-A	2.0•	4.0•						N
CP206-A	2.5•		3/3.4Pk	0.5•				C88
CP205-A	1.0•		1.5/1.7Pk	0.5•				BAA
CP162-A	3.0•		5/6Pk	0.6•				131
CP498-A	6.0•	5/11Pk		.25 or .55				131
CP503-A	6.0•	1.0	2.4/4Pk		1.0			C88

Δ REFER TO SPECIAL OPERATING NOTE

• indicates OVP

— indicates remote sense

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

FEATURES

- VDE transformer construction
- ±.05% regulation
- T.C. burned-in to MIL-883 Lev. B
- Chassis notched for AC input
- 100/120/220/230-240 VAC
- Industry standard size
- 2 hour burn-in period
- Remote sense – most outputs
- UL recognized/CSA certified
- OVP on 5V outputs
- Full-rated to 50°C
- Foldback/current limit

SPECIFICATIONS

AC INPUT: 100/120/220/230-240 VAC•• +10%, −13%, 47–63 Hz. (Derate output current 10% for 50 Hz operation.) See AC connection table under APPLICATION NOTES for jumper information. Fuse information is next to outline and mounting drawings.

DC INPUT: See Voltage/Current Rating Chart. Adjustment range ±5% minimum. (+5 non-adjustable on CP340-A model.)

LINE REGULATION: ±.05% for a 10% line change (±.01% for F,G & CP197-A).

LOAD REGULATION: ±.05% for a 50% line change (±.02% for F,G & CP197-A).

OUTPUT RIPPLE: 2V to 15V units: 5.0mV PK-PK maximum. 20V to 200V units: .02% PK-PK maximum.

TRANSIENT RESPONSE: ≤50us for a 50% load change.

SHORT CIRCUIT AND OVERLOAD PROTECTION: Automatic current limit/foldback.

OVERVOLTAGE PROTECTION: Built-in on all 5V outputs. Set at 6.2V ±.4V. Other models use optional overvoltage protection.

REMOTE SENSING: Provided on most models, open sense lead protection built-in.

STABILITY: ±0.3% for 24 hour period after 1 hour warm-up.

TEMPERATURE RATING: 0°C to 50°C full-rated, derated linearly to 40% at 70°C. 12 CFM forced air cooling required to meet IEC 380/950 above 80% of total rated output power.

TEMPERATURE COEFFICIENT: ±.03%/°C maximum.

EFFICIENCY: (typical) 5V units: 45%; 12V and 15V units: 55%; 20V and 24V units: 60%

VIBRATION: Per MIL-STD-810C, Method 514, Procedure X, CAT C-1

SHOCK: Per MIL-STD-810C, Method 516, Procedure V

••Tolerance for 230VAC operation is +15%, −10%

WARRANTY

POWER-ONE, INC. warrants each power supply of its manufacture that does not perform to published specifications, as a result of defective materials or workmanship, for a period of two (2) full years from the date of original delivery.

POWER-ONE, INC. assumes no liabilities for the consequential damages of any kind through the use or misuse of its products by the purchaser or others. No other obligations or liabilities are expressed or implied.

PRODUCTS RETURNED FOR REPAIR

Please follow this procedure when returning products for servicing:

1. Contact Power-One's Customer Service Department for authorization to return products:

   POWER-ONE, INC.
   740 Calle Plano
   Camarillo, CA 93012
   USA

   PHONE: (805) 987-8741
   (800) 678-9445
   FAX: (805) 388-0476
   TWX: 910-336-1297

2. A Returned Material Authorization (RMA) will be issued and must appear on all shipping documents and containers.

3. Products must be returned freight pre-paid. Products returned freight collect or without an RMA number will be rejected and returned freight collect.

APPLICATION NOTES:

REMOTE SENSE

Remote sense terminals may be used to compensate for output line losses and provide for a remote point of regulation. Figure 1 shows the proper termination for a power supply with remote sensing.

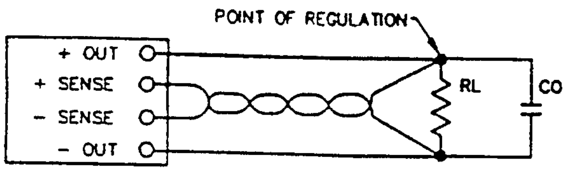


FIGURE 1

Load lines must be sized to prevent an excessive voltage drop from the output to the load. Since the point of regulation is at the load, the power supply must compensate for line losses. Excessive load line losses may affect current limiting, AC line dropout point and OVP margin (if applicable).

Leads should be sized to drop no more than 0.5V − the less the better. Use of a twisted pair or shielded pair for the sense lines is recommended for noise immunity. In problem applications, the use of a small AC decoupling capacitor (.1 to 10uF) across the sense terminals is highly recommended. In some applications there may be a tendency for the power supply to oscillate due to additional phase shift caused by the series resistance and inductance in the load leads. The addition of capacitor Co will reduce output impedance and provide stability. the recommended value of Co is 100uF per ampere or 50uF per foot and can be the sum of the distributed decoupling capacitors found in most systems.

All Power−One supplies have open sense lead protection to protect the load from an overvoltage condition if the sense leads are removed. There is no need to strap the sense terminals to the output terminals in the local sense mode.

OVERVOLTAGE PROTECTION (OVP)

An overvoltage protection circuit, commonly refered to as a crowbar, is used to prevent damage to voltage sensitive loads such as TTL logic. Trip point of the OVP is usually set at 115% − 135% of the output voltage. The OVP will short the output terminals upon sensing a fault condition. The primary fuse of the supply will blow if the supply is not foldback current limited. Nuisance tripping of the OVP is a common problem. Noise from input line spikes or load noise can cause an OVP to fire. The INTERNATIONAL SERIES has OVP noise filtering to prevent nuisance tripping and reduce transformer interwinding capacitance to minimize input line susceptibility.

COMMON−MODE LATCH UP

In certain instances dual power supplies can exhibit a problem known as common−mode latch up. This occurs when the positive supply comes up first and forces a reverse bias condition on the negative supply. The negative supply latches up in a current limit condition. Power−One has incorporated a unique anti−latch circuit into every dual power supply in the INTERNATIONAL SERIES which will minimize this problem.

EMI/RFI

These linear power supplies have inherently low conducted and radiated noise levels. For most system applications they will meet the requirements of FCC Docket 20780 for Class A equipment and VDE 0871 for Class A equipment without additional noise filtering. For special applications consult factory.

COOLING

Convection cooling is adequate where non−restricted air flow is available. When operating in a confined area, moving air or conduction cooling is recommended.

SAFETY SPECIFICATIONS

The INTERNATIONAL SERIES power supplies were designed to meet or exceed requirements for the following specifications: IEC 380, IEC 435, DE 0730 Part 2, VDE 0804, ECMA−57, CEE 10 Part 2P, UL 1012, CSA 22.2 No. 143, CSA 22.2 No. 154. Specifically field terminal to terminal spacing is 5.25 mm with 9.0 mm creepage to other metal, leakage current is less than 5.0uA and dielectric withstanding voltages are 3750 VAC input to chassis, 3750 VAC input to output and 300 VDC output to chassis.

GROUNDING

Grounding considerations in designing a power distribution system are often overlooked but can have a significant impact on overall system performance. A single point system ground should be employed where possible to eliminate ground loops and improve regulation.

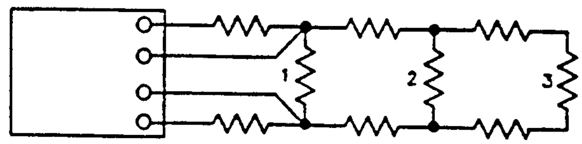


FIGURE 2

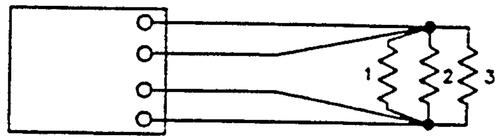


FIGURE 3

Figure 2 shows a simple but undesirable connection scheme. Regulation at loads 2 and 3 becomes progressively worse due to voltage drops in the finite wire resistance between loads. Figure 3 shows an improved connection system in which regulation is maintained at all three loads because wire losses are not cumulative.

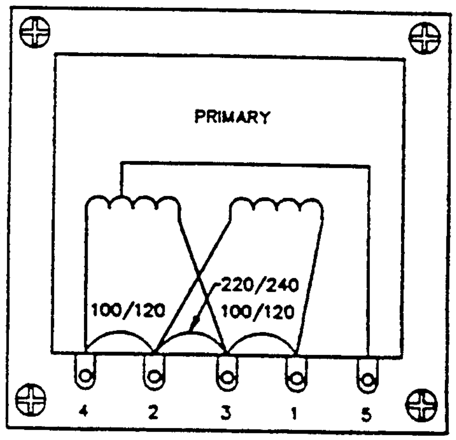
AC INPUT CONSIDERATIONS

Almost all power supplies use a capacitive input filter that draws current only at the peaks of the AC input voltage. The peak to RMS ratio can be very high, typically 3 to 1. When a supply is turned on, the input capacitor has a very low impedance and draws an initially high surge current until it charges to its nominal voltage. The input surge current can be as high as 20 times the rated input current and lasts for several cycles of the AC input.

AC CONNECTION AND FUSING•

The five wire input to the INTERNATIONAL SERIES provides four voltage ranges: 100/120/220/230−240•• +10% −13%. See chassis AC connection table (Figure 4) for the jumpering requirements. For convenience the jumper sequence from the Hi−Vol series is retained. Extended low line tolerance provides additional drop out margin in areas where line voltages are marginal. Inputs must be fused.

FIGURE 4



AC INPUT, 47−63 HZ				
FOR USE AT	100 VAC	120 VAC	220 VAC	230/240 VAC
JUMPER	1&3 2&4	1&3 2&4	2&3	2&3
APPLY AC	1&5	4&1	1&5	4&1

NOTE: This product is a Class 1 power supply and requires the chassis to be connected to earth ground at end application.

•NOTE: Use 700°C iron for soldering input connections. Varnish acts as flux and is solder strippable.

SPECIAL OPERATING NOTE:

MASTER/SLAVE USAGE: General Notes – In Master/Slave connection, the master unit will control up to 5 slaves; however, in an over current condition, each supply will operate its own current limit/foldback circuit for protection.
The sharing of current at full load is within ±10%.

OVP – If any supply senses an over voltage condition, it will fire and shut off drive to all units. No power is consumed in the OVP mode and OVP may be reset by removal of input power or the momentary grounding of inhibit (to – out).

Remote program, remote V. adj., remote OVP and inhibit all may be connected to the master and will operate identically to a single unit (inhibit is 30mA per unit).

Individual fusing is recommended for each supply. In the case of any blown input fuse, the output voltage will be reduced to < 3V with a nominal load.

SLAVE CONFIGURATION: To make any unit a slave, adjust R12 (R16) (V. ADJ.) fully counter-clockwise.

MASTER CONFIGURATION:
1) Connect all master and slave + and – output terminals to the load with seperate equal length wires of adequate size.
2) Fuse each power supply individually to the AC power input.
3) Connect a #20GA wire from "Ext.Dr." on the master to the "Ext.Dr." on all the slaves (up to 5 slaves).
4) Apply input power and set master to desired voltage.

REMOTE PROGRAM: Remove R21 (R20). Install program resistors between power supply "+ sense" and users "+ load" terminals. Programming is approximately 500Ω/volt. Use "Make-Before Break" switch or equivalent.

REMOTE V. ADJ:
1) Cut open-lead protection resistor R21 (R20) out of the circuit board.
2) Connect remote 1K pot from power supply "+ sense" terminal to users "+ load" terminal. (Power supply will then sense to "+ load" terminal and be remotely adjustable).
3) Adjust R12 (R16) on circuit board fully counter-clockwise.
4) Adjust remote pot to desired voltage.

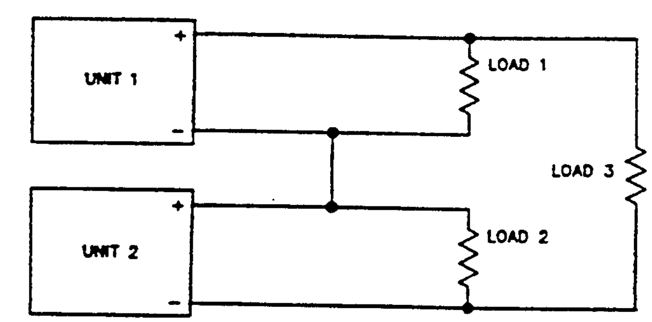
ADJUSTABLE OVP: To set OVP at desired voltage:
A) Set R16 to max. (fully clockwise).
B) Set supply to desired trigger voltage.
C) Reduce R16 resistance until OVP fires.
D) Ground inhibit to reset OVP, then recheck OVP trigger point.
E) Reset supply voltage to normal output.

NOTE: ( ) DENOTES DESIGNATIONS USED FOR F15-15-A AND F24-12-A.
THE OTHER DESIGNATIONS ARE USED ON F5-25/OVP-A, G5-35/OVP-A, AND CP197-A MODELS.

OPERATING NOTES ABOVE APPLY TO F, G AND CP197-A UNITS ONLY.

SERIES OPERATION

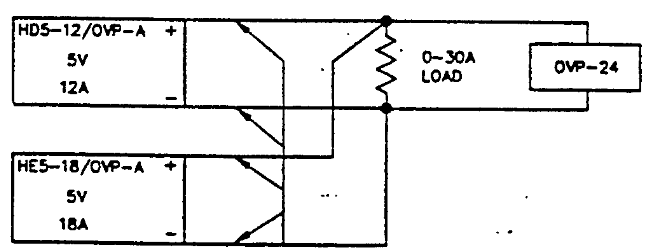
Any Power-One supply may be operated in series with any other Power-One power supply. The only restriction is that the current required by load 3 must be less than half the current rating of the lesser unit.



PARALLEL OPERATION

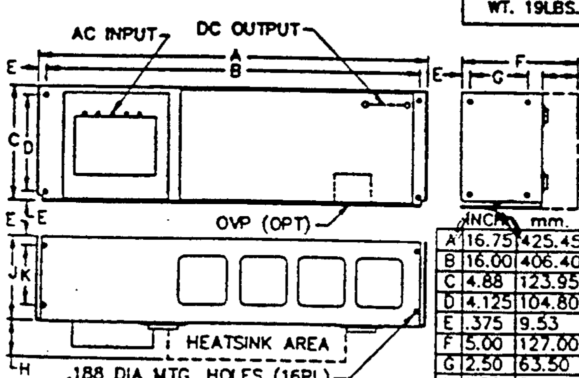
Any 2 or more Power-One units of the same voltage may be operated in parallel. The following rules apply:

1) The units must be set to the same voltage within .2%.
2) Local sense must be used.
3) Units may be of different current ratings.
4) Proper hook-up wire must be utilized.



Calculate wire size and length to drop 25, 50, or 100 mV on 5, 15, or 24V units respectively, at unit rated current.

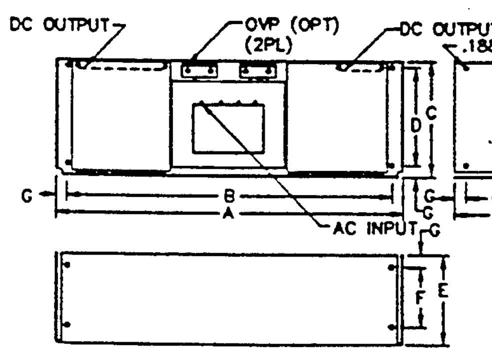
F CASE
WT. 19LBS.



	INCH	mm.
A	16.75	425.45
B	16.00	406.40
C	4.88	123.95
D	4.125	104.80
E	.375	9.53
F	5.00	127.00
G	2.50	63.50
H	1.50	38.10
J	3.50	88.90
K	2.50	63.50

... FUSING RECOMMENDATION, REFER TO CHASSIS SILKSCREEN.

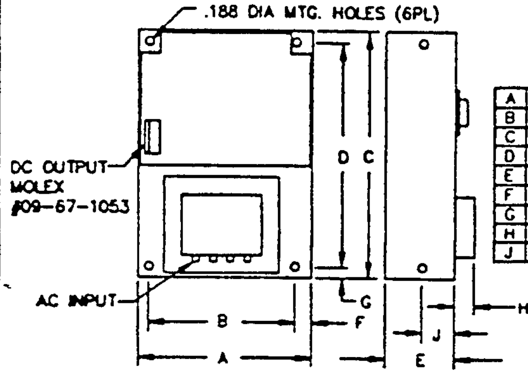
DCC CASE
WT. 12LBS.



	INCH	mm.
A	15.00	381.00
B	14.00	355.60
C	4.88	123.95
D	4.13	104.90
E	3.75	95.25
F	2.50	63.50
[illegible]	[illegible]	[illegible]
H	0.80	20.32

FUSE AT [illegible]

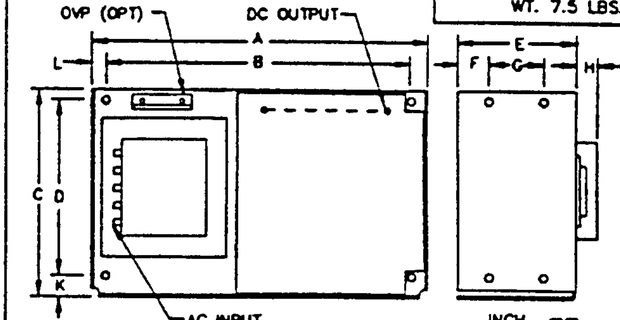
CP340-A CASE
WT. 2 LBS.

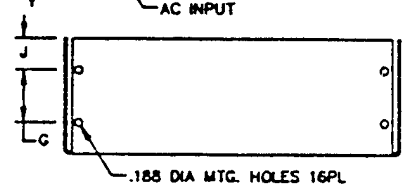


	INCH	mm.
A	4.00	101.60
B	3.375	85.73
C	5.50	139.70
D	5.00	127.00
E	1.62	41.15
F	.375	9.53
G	.250	6.35
H	.450	11.43
J	.750	19.05

FUSE AT 0.5/0.25AMPS FOR 100-120/220-240VAC

CP510-A CASE
WT. 7.5 LBS.

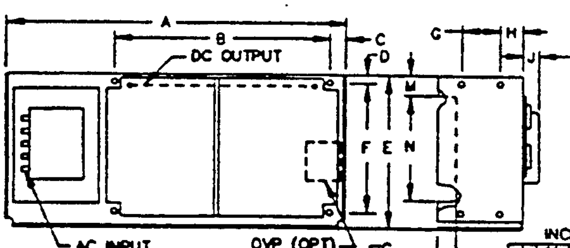


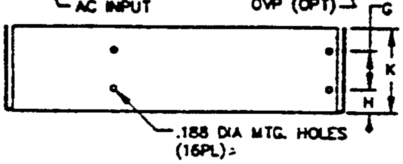


	INCH	mm.
A	8.25	209.55
B	7.50	190.50
C	4.87	123.70
D	4.125	104.78
E	2.75	69.85
F	.75	19.05
G	1.25	31.75
H	.50	12.70
J	.75	19.05
K	.500	12.70
L	.350	8.89

FUSE AT: 3.0/1.5AMPS FOR 100-120/220-240VAC

131 CASE
WT. 9 LBS.

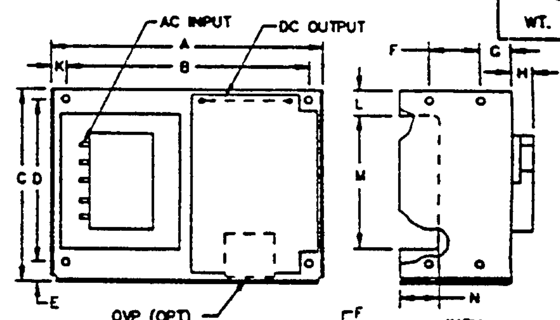


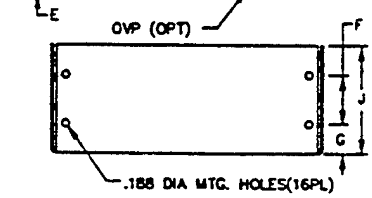


	INCH	mm.
A	11.00	279.40
B	7.000	177.80
C	0.50	12.70
D	0.25	6.35
E	4.87	123.70
F	4.125	104.78
G	1.250	31.75
H	0.75	19.05
J	0.525	13.34
K	2.75	69.85
L	0.600	15.24
M	0.640	16.26
N	3.35	85.09

FUSE AT: 3.0/1.5 AMPS FOR 100-120/220-240 VAC

N CASE
WT. 6 LBS.

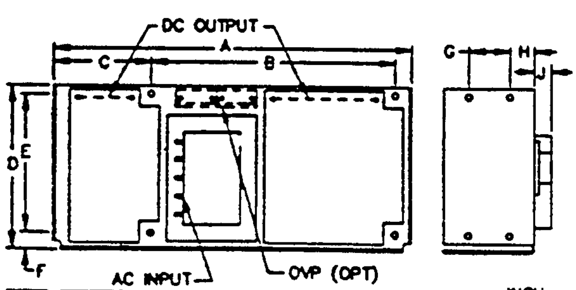


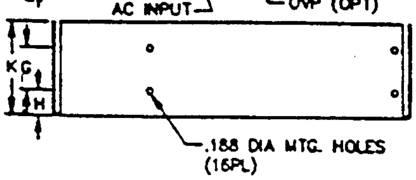


	INCH	mm.
A	7.00	177.80
B	6.250	158.75
C	4.87	123.70
D	4.125	104.78
E	0.50	12.70
F	1.250	31.75
G	0.75	19.05
H	0.525	13.34
J	2.75	69.85
K	0.38	9.65
L	0.640	16.26
M	3.35	85.09
N	1.00	25.40

FUSE AT: 2.0/1.0 AMPS FOR 100-120/220-240 VAC

CBB CASE
WT. 8 LBS.

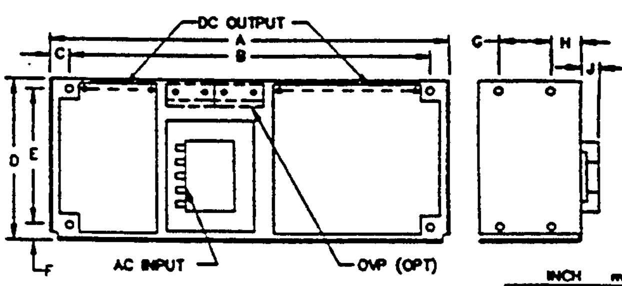


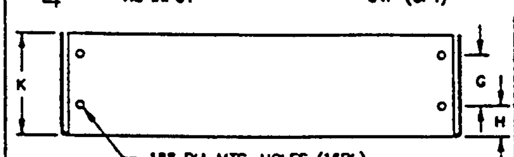


	INCH	mm.
A	11.00	279.40
B	7.500	190.50
C	3.00	76.20
D	4.87	123.70
E	4.125	104.78
F	0.50	12.70
G	1.250	31.75
H	0.75	19.05
J	0.525	13.34
K	2.75	69.85

FUSE AT: 2.0/1.0 AMPS FOR 100-120/220-240VAC

BAA CASE
WT. 5 LBS.





	INCH	mm.
A	10.25	260.35
B	9.250	234.95
C	0.50	12.70
D	4.00	101.60
E	3.375	85.73
F	0.37	9.40
G	1.250	31.75
H	0.75	19.05
J	0.450	11.43
K	2.50	63.50

FUSE AT: 1.0/0.5 AMPS FOR 100-120/220-240 VAC

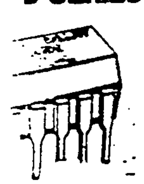
425 SERIES GENERAL PURPOSE SCREW MOUNT RELAYS

...cognized and CSA certified. Silver cadmium oxide contacts. Dielec... 2500VAC, 60Hz. 425XAX are "hot" armature 300V, SPDT, 30-amp ...5BXX and 425XBX are insulated armature 600V, 30-amp models; ...ST-NO. 425XBX DPDT. 425CXX is a 3PNO open type rated 25 amps ...nd 10 amps at 600VAC. 425XCX is a 3PDT open type rated 25 amps at 10 amps at 600VAC. Ideal for such applications as motors, solenoids, compressors.

	Type	Volts	Coil Res. Ω	Contacts	1-24
	425XAX	120AC	290	SPDT	15.88
	425XAX	12DC	3.2	SPDT	15.21
	425BXX	24AC	12	DPST-NO	17.18
	425BXX	120AC	290	DPST-NO	17.18
	425BXX	240AC	1200	DPST-NO	17.48
	425XBX	120AC	290	DPDT	21.27
	425XBX	240AC	1200	DPDT	21.58
	425XBX	12DC	3.2	DPDT	20.84
	425XBX	24DC	12	DPDT	20.84
	425XBX90*	120AC	290	DPDT	26.36
0	425XCX	120AC	170	3PDT	37.34
5	425CXX	120AC	170	3PNO	32.74
8	425CXX	24DC	6.7	3PNO	31.34

...iliary contacts.

...-D SERIES DIP PACKAGE DRY REED RELAYS



Dry reed DIP relays operate from DTL, TTL, or HNIL logics. 1 form A and 1 form C models measure .750Lx.300Wx.275"H; 2 form A models measure .750Lx.300Wx.350"H. 1 form A and 2 form A units carry 10VA loads; 1 form C rated at 3VA. Available in 8-pin and 14-pin models. Operating temperature range: −20°C to +105°C. 0.1" standard dual-in-line grid spacing. *14-pin models mate with type 33377 socket ordered separately below.*

Type	Pins	Contacts	VDC	Ohms	1-24	25-49	50-99
MRR1ADS	14	1A	5	360	4.83	4.59	4.11
MRR1ADS8	8	1A	12	1440	4.83	4.59	4.11
MRR1ADSR	14	1A	5	500	5.67	5.39	4.95
MRR1CDL	14	1C	5	100	9.67	9.20	8.23
MRR1CDL8	8	1C	12	500	9.67	9.20	8.23
MRR2ADLX	14	2A	5	125	8.08	7.68	6.87
MRR2ADLX8	8	2A	12	500	8.08	7.68	6.87

SOCKET FOR MRR-D SERIES RELAYS

No.	Type	Pins	Size	Each
...65	33377	14	2⅞Wx3⅝Lx$^{47}/_{64}$H	8.22

TYPE A575 7.5HP REVERSING CONTACTOR

Definite purpose contactor finds use in a range of applications requiring frequent jogging: hoists, overhead doors, elevators, and machine tools. Silver cadmium oxide contacts rated 30 amps, 120 VAC. 2 sets of 3-pole, double make NO contacts are interlocked to prevent simultaneous closure. UL listed.

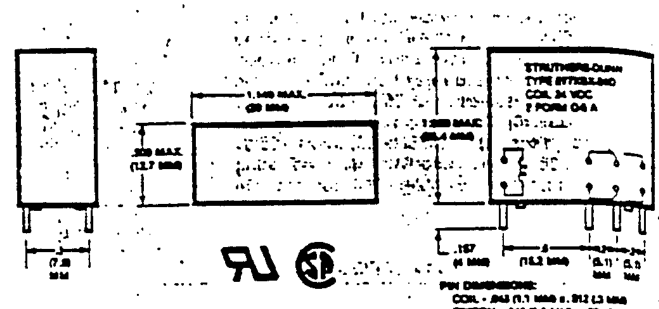
No.	Type	Volts	Ohms	Contacts	1-49
3	A575KXX	120VAC	1450	3 DM NO	133.77

TYPE A275 REVERSING CONTROL CONTACTORS

Compact, reversing contactors for continuous operation in heavy-duty service. Terminals mate with standard .250" quick-connect receptacles. Contact ratings: 120VAC, 1HP; 240VAC, 1 and 2HP, 480/600VAC, 1HP. UL listed, CSA certified 1HP only. Type A275KXX: 6 load contacts, 1 set 3-NO-DB contacts per coil and armature. A275KXX90: Same but have SPDT auxiliary contacts for coil interlocking or electric lock-up. A275KXX91: Same but have DPDT auxiliary contacts for coil interlocking and electric lock-up or operating indicator lamps.

77	A275KXX	24VAC	4.8	3 DM NO	37.32
73	A275KXX	120VAC	132.0	3 DM NO	37.32
72	A275KXX90	120VAC	132.0	3 DM NO	46.72
62	A275KXX91	24VAC	4.8	3 DM NO	52.06
63	A275KXX91	120VAC	132.0	3 DM NO	52.06

277 SERIES 5-AMP MINIATURE PC RELAYS

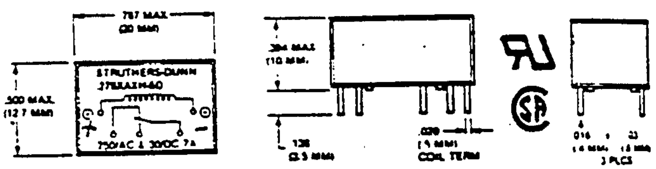


- 2 Form C
- Silver Contacts Rated 5 Amps

277 Series relays have PC terminals on 0.1" (2.54) grid spacing, and are available with AC or DC coils. Epoxy sealed terminal base prevents contamination during soldering. 10kV surge resistance, 8mm separation between coil and contacts also featured. Operate and release times are under 15 milliseconds. Silver contacts pick up at 75% nominal, drop out at 10%. Resistive load: 5 amps, 240VAC or 30VDC. UL recognized, CSA certified at 5 amps and 1/10HP.

Stock No.	Type	Coil	Ohms	1-24	25-49	50-99
46F5368	277XBX	24VAC	248	5.01	4.76	4.26
46F5369	277XBX	120VAC	6800	5.90	5.61	5.02
46F5370	277XBX	5VDC	47	4.54	4.32	3.86
46F5371	277XBX	12VDC	275	4.54	4.32	3.86
46F5372	277XBX	24VDC	1100	4.54	4.32	2.86

276 SERIES 7-AMP PC RELAYS

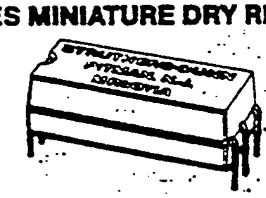


- Only 0.4 square inch footprint
- Silver Contacts Rated 7 Amps
- Permanent Magnet Polarized, Single-Side Stable Design
- 1 Form C

276 Series feature grid pin spacing of 0.1" and require 0.393" clearance above the board. Available with sealed PBT case for automatic wave-soldering and immersion cleaning, units provide maximum contact current at 7 amps, 240 VAC or 30 VDC and up to 380VAC and 125VDC at lower currents. 5kV surge resistance, 4mm separation between coil and silver contacts. UL recognized, CSA certified at 7 amps 1/10 HP.

Stock No.	Type	Coil	Ohms	1-24	25-49	50-99
46F5389	276XAXH	5VDC	125	3.65	3.47	3.11
46F5390	276XAXH	12VDC	720	3.65	3.47	3.11
46F5391	276XAXH	24VDC	2880	3.96	3.77	3.37

MR-Y SERIES MINIATURE DRY REED RELAYS



MR-Y Series encapsulated dry reed relays are available with end pin terminals on 1-inch centers. Type MR30Y offer 0.100 inch pin spacing, and type MR35Y ... for 0.150 inch pin spacing. Available 1 form A, 2 form A and 1 form C (see type suffix). Form A contacts are rated for 10 watts maximum at 200VDC maximum, ... 0.500 amps max. Form C contacts have a rating of 3 watts max. at 28VDC max., ... 0.250 amps max. 0.312" height for all models.

Stock No.	Type	VDC	LxWxH"	Ohms	1-24	25-49	50-99
WITH 0.100" GRID SPACING							
89F1873	MR30Y1A	12	1.000x0.400x0.312	400	6.09	5.79	[illegible]
89F1874	MR30Y1A	24	1.000x0.400x0.312	1600	6.09	5.79	[illegible]
89F1875	MR30Y2A	12	1.000x0.550x0.312	400	8.48	8.06	[illegible]
89F1876	MR30Y2A	24	1.000x0.550x0.312	1600	9.99	9.49	[illegible]
89F1877	MR30Y1C	12	1.000x0.400x0.312	400	10.02	9.65	[illegible]
89F1878	MR30Y1C	24	1.000x0.400x0.312	1600	11.00	10.46	[illegible]
WITH 0.150" GRID SPACING							
89F1879	MR35Y1A	12	1.000x0.400x0.312	400	6.09	5.79	[illegible]
89F1880	MR35Y1A	24	1.000x0.400x0.312	1600	6.09	5.79	[illegible]
89F1882	MR35Y2A	24	1.000x0.550x0.312	1600	9.99	9.49	[illegible]
89F1883	MR35Y1C	12	1.000x0.400x0.312	400	10.02	9.65	[illegible]
89F1884	MR35Y1C	24	1.000x0.400x0.312	1600	11.00	10.46	[illegible]